This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

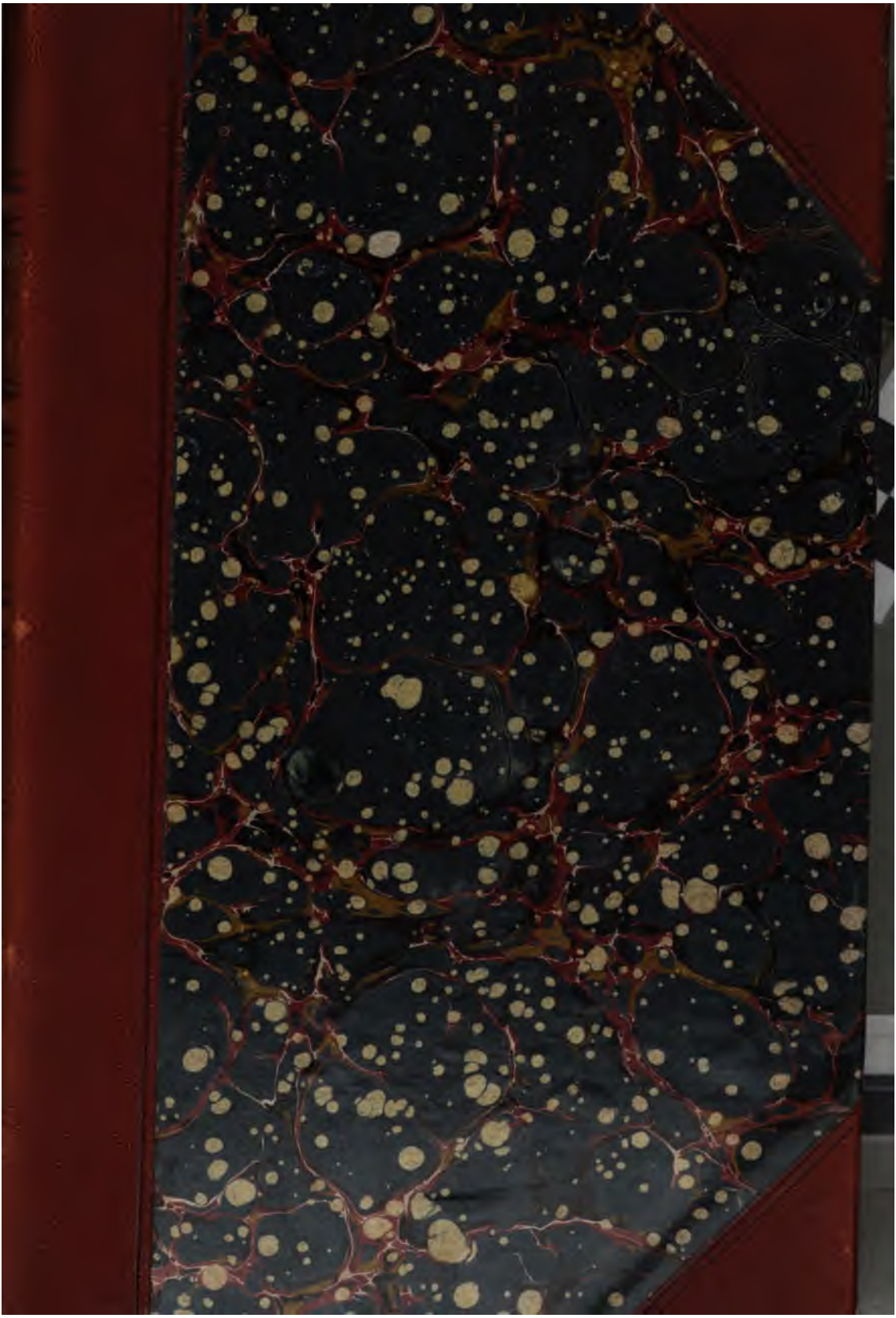
Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



The Branner Geological Library

LELAND·STANFORD JVNIOR·VNIVERSITY

0.6
M26

TRANSACTIONS

OF THE

MANCHESTER

GEOLOGICAL SOCIETY.

VOL. V.

LONDON:
SIMPKIN, MARSHALL AND CO.;
AND "THE MINING JOURNAL" OFFICE, 26, FLEET STREET.
MANCHESTER:
THOMSON AND BAXTER, 40, PRINCESS STREET.
MDCCCLXVI.

212956

STANFORD LIBRARY

130

CONTENTS OF VOLUME V.

	PAGE
No. 1.—Reports of Twenty-sixth Annual Meeting, held October 27th, 1864	1
Honorary Curator's Report	2
Report of Council	5
List of Papers Read, 1863-4	6
List of New Members Elected ;—Deceased Members	7
Treasurer's Balance Sheet	8
List of Officers for 1864-5	9
Rules of the Society	11
List of Members of the Society	21
2.—Paper—Manchester Geological Society's Excursion to Llangollen; by Mr. John E. Forbes, F.G.S.	30
Paper—On the South-Eastern Portion of the Somersetshire Coal-Field; by Mr. G. C. Greenwell, F.G.S.,—with Lithographed Sections	34
Discussion	38
3.—Paper—On the Pliocene and Post-Pliocene Deposits, in the neighbourhood of Norwich; by Mr. John Taylor	44
Discussion	53
Paper—On the Alluvial Deposits on Travis Isle, Collyhurst; by Mr. John Plant, F.G.S.	56
Discussion	59
4.—Mr. Greenwell—On Limestone Fissure, near Nunney, Somersetshire	63
Presentations to the Society	65
Paper—Additional Notes on the Drift Deposits in Burnley and the Neighbourhood; by Mr. T. J. Wilkinson	65
Discussion	73
Paper—On the Discovery of Paradoxides Davidis; by Mr. John Plant, F.G.S.,—with Plate and Sections	76

PAGE

No. 5.—Donations to the Museum and Library 81

Remarks on the Macclesfield Drift Fossils; by Mr. Plant..... 82

PAPER—On Certain Appearances of Glacial Action near Clitheroe; by Mr. John Aitken 87

Discussion 91

PAPER—On the Outcrop of the Lower Coal-Measure Rocks, on Bouldsworth and Gorple; by Mr. Joseph Whitaker 94

Discussion 104

6.—Mr. R. D. Darbishire, F.G.S.,—On the Fossils found in the Drift at Macclesfield 105

On Macclesfield Drift Shells; by Mr. Sainter 114

7.—PAPER—On Wire Ropes; by Mr. G. C. Greenwell, F.G.S. 122

Discussion 129

8.—Description of Dumas' Lamp for the Use of Mines 132

Discussion on same 137

Remarks on Testing for Fire Lamp, from Experiments; by Mr. Ansell 139

9.—Donations to the Museum.... 141

PAPER—On Pit-Head Frames; by Mr. J. J. Horsfall,—with Diagrams 142

10.—Reports of the Twenty-seventh Annual Meeting, held October 26th, 1865 149

Honorary Curator's Report 150

Report of the Council 151

List of Papers Read, 1864-5 152

Treasurer's Balance Sheet 153

List of New Members—Deceased Members—Members who have Resigned 154

List of Officers, 1865-6 155

11.—Opening Address—On the Objects of the Manchester Geological Society, and the best means of attaining them; by E. W. Binney, Esq., F.R.S., F.G.S., President..... 158

12.—Presentation to the Museum 181

PAPER—On Safety Cages; by Mr. J. J. Horsfall 182

PAPER—The Union of the Gannister and Higher Foot Coal Mines at Bacup; by Mr. John Aitken,—with Section ... 185

Discussion 190

13.—Presentation to the Library 193

Notes on the Accommodation Mine at Poynton,—with Sections, by Mr. G. C. Greenwell, F.G.S. 194

PAPER—On Geology in its Relation to Archæology; by Mr. Charles Hardwick..... 201

Discussion 215

PAGE

No. 14.—Paper—The Geology and Fossils in the Gold Districts of North Wales; by Messrs. Plant and Williamson,—with Sections 220

15.—Discussion on Fossils Found in the Wigan Coal Field 235

Paper—On a Fossil Shell from the Oil Wells of Canada; by Mr. W. R. Barr, F.G.S. 236

Discussion 240

16.—Letter from Mr. Mark Fryar 245

Paper—On the Hæmatite Mines of the Ulverstone District; by Mr. G. C. Greenwell, F.G.S. 248

Discussion 252

17.—The President—On Specimens of Cannel Coal sent from New South Wales by Mr. John Mackenzie 255

Paper—On the Best Methods to produce Coal in a Marketable Condition; by Mr. John Warburton 257

Discussion 265

Papers—On Recent Evidences of Human Habitation in Poole's Cavern, Buxton; and On the Existence of a Sea Beach on the Limestone Moors, near Buxton; by Mr. John Plant, F.G.S. 269

THE Council of the "MANCHESTER GEOLOGICAL SOCIETY" make it known to the Public that the Authors and Speakers alone are responsible for the facts, reasonings, and opinions given in the respective Papers and Discussions in this volume.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

The Current Numbers of the "Transactions of the Manchester Geological Society" are now on sale at Messrs. Thomson & Baxter's, 40, Princess Street, and at "The Mining Journal" Office, 26, Fleet Street, London.

Manchester:

THOMSON & BAXTER, PRINTERS, &c., 40, PRINCESS STREET.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 1.] VOL. V. [Session 1864-65.

The Annual Meeting of the Manchester Geological Society was held in the Museum, Peter-street, October 27th, 1864.

ANDREW KNOWLES, Esq., President, in the Chair.

The President opened the proceedings by saying that they were met together to transact the business that was usually transacted at the Annual Meeting,—to hear the Reports of the Council, of the Curators, and of the Treasurer read, and to do any other business that was requisite.

Mr. Forbes, Honorary Secretary, then read the various reports, and the Treasurer's statement of accounts.

HONORARY CURATORS' REPORT.

The Honorary Curators reported the receipt of the following donations in the course of the last session :—

FOSSILS, &c.

PRESENTED BY MR. H. BAINES—

1.—Two Silicious Stones, found in the Trencherbone Mine.

PRESENTED BY MR. R. A. ESKRIGGE—

2.—Specimens from the Lower Silurian Formation, on the Llandeilo Flags.

PRESENTED BY MR. WILD—

3.—Specimen of Calamites.

PRESENTED BY MR. BALDWIN—

4.—Specimens of Aviculopecten, from the Drift Gravel, near Bury.

PRESENTED BY MR. GRINDLEY—

5.—Specimens of Impressions on Slates, from Laxey, Isle-of-Man.

PRESENTED BY MR. GREENWELL—

6.—Specimen of Titanium.

PRESENTED BY MR. GOODWIN—

7.—Specimen of Westbury Cannel, from Broomstair Haughton Colliery.

8.—Specimen of Lepidodendron, from the Cannel Mine, Haughton.

PRESENTED BY MR. DICKINSON—

9.—Specimens taken from the Rocks, now being Tunnelled at Mount Cenis.

PRESENTED BY MR. PARKER—

10.—Specimens of Selenite, from Kersall Colliery, near Clifton.

Also a valuable Collection of Reptilian and Saurian Remains from the Scotch Coal-field, near Airdie; collected by MR. RUSSELL, and Presented to the Society by a number of Gentlemen, who purchased and presented it to the Society.

PRESENTED BY MR. GEORGE WILD—

Model of a Safety Sinking Capstan Hoist Hook.

PRESENTED BY O. A. FERRIS, ESQ.—

Raised Map of the High Peak; Colored by the late Mr. Elias Hall, of Castleton.

PRESENTED BY CAPTAIN AITKIN—

Cast of a Pterodactyl.

BOOKS, &c.

PRESENTED BY MR. E. HULL, B.A., F.G.S.

1.—On the Geology of the Country round Oldham; including Manchester and its Suburbs;--BY THE AUTHOR.

PRESENTED BY MR. E. W. BINNEY, F.R.S., &c.—

2.—Further Observations on the Carboniferous, Permian, and Triassic Strata of Cumberland and Dumfries.—BY THE AUTHOR.

PRESENTED BY THE UNITED STATES GOVERNMENT—

3.—Reports of the Commission of Patents,—Agriculture.

PRESENTED BY THE AUTHORS—

4.—Proceedings of the Geologists' Association.
5.—Mining and Smelting Magazine.
6.—Journal of the Royal Dublin Society.

PRESENTED BY THE COUNCILS—

7.—Memoirs of the Literary and Philosophical Society of Manchester.
8.—Quarterly Journal of the Geological Society.
9.—Proceedings of the South Wales Institute of Mining Engineers.
10.—Transactions of the North of England Institute of Mining Engineers.
11.—Proceedings of the Liverpool Geological Society.
12.— " " Leeds Philosophical and Literary Society.

REPORT OF THE COUNCIL.

Your Council, in resigning the office they have held during the past year, present to the members, according to the rules of the Society, a brief report of their proceedings during their year of office, accompanied by the Treasurer's account of the receipts and disbursements connected with the business of the Society—a list of donations by which the Library and Museum has been enriched, and a list of papers read during the session.

In the past year twenty new members have been elected, a few have withdrawn, and two are dead.

A field day and excursion was made to Llangollen on the 14th and 15th July, in connection with the Liverpool Geological Society, and the Dudley and Midland Geological Society and Field Club. About twenty of our members joined, and much valuable information was obtained. An account of the excursion is being prepared, and will be presented to the Society.

The Council have to regret the great loss which the Society has sustained by the death of their late indefatigable Honorary Secretary, Mr. John Atkinson, F.G.S. Besides contributing several valuable papers to the Transactions of the Society, and effectively performing the duties of active Honorary Secretary, for the last four years of his membership he acted as Editor of the Memoirs. All the members who had the pleasure of his acquaintance will know how to appreciate the value of his services, and estimate the loss which the Society has sustained by his removal from amongst us.

LIST OF PAPERS READ, SESSION 1863-64.

On some Flint Arrow Heads, from Canada.—By F. R. Fairbank, L.R.C.P., &c.

On the Occurrence of Glacial Striations of the Surface of Bidston Hill, near Birkenhead.—By Edward Hull, B.A., F.G.S.

On the Discovery of Coal in Brazil.—Communicated by Mr. John Plant.

On the Drift Deposits in the Neighbourhood of Crewe.—By Mr. John Taylor.

On the Lias of Cheshire and Shropshire.—By Mr. R. A. Eskrigge

On the Quaternary Deposits of the Valley of the Mersey, near Stockport.—By W. R. Barr, F.G.S.

Remarks on the Subsidence of the Surface consequent upon the Working of Coal Mines.—By Joseph Goodwin, M.E.

On Modern Scriptural Geology.—By Joseph Dickinson, F.G.S.

On Colliery Accidents.—By Mr. John Warburton.

LIST OF NEW MEMBERS ELECTED IN THE SESSION 1863-64.

Mr. William Taylor, Hazlehead, Yorkshire.

Mr. Jonathan Bromley, 45, Exchange Arcade, Manchester.

Mr. William Brooke, 112, Upper Brook Street, Manchester.

Captain Rhodocanakis, Higher Broughton.

Mr. J. B. Whitehead, Rawtenstall.
Mr. Robert Winstanley, 94, Cross Street, Manchester.
Mr. J. S. Middleton, Whalley Range.
Mr. John Swain, Engineer, Hyde.
Mr. Abel Lees, Bardsley.
Mr. Samuel Hall, Bacup.
Mr. W. J. Sleath, Bacup.
Mr. C. Hardwick, 100, City Road, Manchester.
Mr. R. R. Bealey, Old Hall, Stand.
Mr. A. G. Henderson, Greenmount Cottage, Harpurhey.
Mr. Joseph Handley, Bury.
Mr. Robert Edmondson, ,,
Mr. Robert Hall, ,,
Mr. James Park, ,,
Mr. Thomas Nuttall, ,,
Mr. Richard Dearden, Little Lever, Bolton.

DECEASED.

Mr. Samuel Brooks, | Mr. John Atkinson.

The President enquired if any gentleman had any question to ask in connection with the reports, and there being no response,

Mr. Dickinson proposed that the reports now read be received and adopted. He was happy to see that there was such a large accession of new blood, and that the Society was increasing in strength year by year.

Mr. Forbes seconded the motion, which was then adopted.

MANCHESTER GEOLOGICAL SOCIETY.

BALANCE SHEET, 1864.

Abstract of Receipts.

1863.		£	s.	d.
To Balance brought down		47	8	10
Subscriptions, 1860-61, 1				
„ „ „ 1861-2, 1				
„ „ „ 1862-3, 9		130	0	0
„ „ „ 1863-4, 117				
„ „ Half-year, 1864, 2				
„ Dividends on Stock		6	16	0
„ Interest Allowed by Bank		2	18	0
„ Proceedings Sold		8	3	4
	£195	6	2	

Abstract of Payments.

1863.	£	s.	d.
By Balance Repaid to Treasurer	10	0	0
„ Library	4	9	6
„ Museum	5	0	0
„ Reports of Meetings	54	10	4
„ Reporters	11	11	0
„ Printing and Stationery	3	3	0
„ Postages, Delivery of Circulars, and Stamps	23	1	2
„ Collector's Commission	6	10	0
„ Insurance of Stock	0	6	0
	118	11	0
„ Balance carried down	76	15	2
	£195	6	2

1864.—Balance brought down £76 15 2

Examined and found correct,

JAMES HERTZ, Auditor.

HENRY M. ORMEROD, Treasurer.

The President said the next proceeding was to elect officers for the ensuing year.

Captain Aitkin had great pleasure in moving that the names about to be submitted to the meeting be elected as officers of the Society for the next year. He supposed the proper course would be to propose the names separately,—not to move the whole list.

Mr. Dickinson replied that they had always been taken together before.

Captain Aitkin said—If that were the usual course, he would propose the entire list.

Mr. Greenwell seconded the list, which was adopted *nem. con.*

President:

ANDREW KNOWLES, Esq.

Vice-Presidents:

E. W. BINNEY, F.R.S., F.G.S.

W. R. BARR, F.G.S.

JOSEPH DICKINSON, F.G.S.

JOSEPH CHATWOOD, Esq.

Treasurer:

HENRY MERE ORMEROD, Esq.

Auditors:

R. P. GREG, F.G.S. | JAMES HERTZ, Esq.

Honorary Secretaries:

JOHN EDWARD FORBES, F.G.S. | G. C. GREENWELL, F.G.S.

Honorary Curators:

MR. E. W. BINNEY. | MR. H. M. ORMEROD.

Other Members of the Council.

Mr. John Aitkin,	Mr. Joseph Goodwin,
„ Thos. Baldwin,	„ J. J. Horsfall,
„ Wm. Bryham,	„ R. M. Knowles,
„ R.D. Darbishire, B.A., F.G.S	„ George Peace,
„ R. A. Eskrigge,	„ Smith,
„ Thomas Farrimond,	„ John Wilde.

And representatives of this Society at the Council Meetings of the Natural History Society,—Mr. E. W. Binney, and Mr. R. D. Darbishire.

Captain Aitkin thought a vote of thanks was due to the gentlemen who had held office for the past year. He believed they had acted with satisfaction to the Society, and the Society would do amiss were they to separate without recording their sense of these labours. He moved that the best thanks of the meeting be given to the President, Vice-Presidents, and other officers of the Society, for their services during the past year.

Mr. Horsfall seconded the motion, which was carried.

The business then terminated, with a vote of thanks to the President for presiding, and the proceedings of the Annual Meeting were brought to a close.

MANCHESTER GEOLOGICAL SOCIETY.

OBJECTS.

The objects of the MANCHESTER GEOLOGICAL SOCIETY *are the collection and diffusion of Practical and Theoretical Knowledge respecting Geology and Mining.*

RULES.

I.—The Society consists of Ordinary, Life, Honorary, and Corresponding Members.

II.—Every candidate for admission into the Society as an ordinary member, must be proposed by two or more members, who must sign a certificate in recommendation of him, setting forth the name, description, and place of residence of the candidate.

III.—The certificate, when duly filled up, shall be read aloud at the next meeting of the Council of the Society; and the election of the candidate shall forthwith be decided by a majority of votes.

IV.—The Secretaries shall address to every person elected a member, a notification of such election with a copy of the printed Rules and Bye-laws of the Society.

V.—No person elected a member shall be entitled to exercise any privilege as such, until he shall have paid his annual subscription, or the composition in lieu thereof.

VI.—The annual subscription to be paid by ordinary members

shall be twenty shillings, due on each successive first day of October, and payable in advance for the current year, and shall be a debt due to and recoverable as such by the Treasurer for the time being.

VII.—Members joining the Society on or after the first day of April in any year, shall pay the sum of ten shillings as the subscription for the current year.

VIII.—An ordinary member may, at his election, or any future period, become a life member by compounding for future annual subscriptions, including that of the current year, by the payment of ten pounds. If he has already paid the subscription for the current year, or any part of it, such payment shall be allowed in part of his composition.

IX.—The payment by an ordinary or life member of the subscription, or the composition in lieu thereof, shall imply the acquiescence of such member in the Laws and Regulations of the Society.

X.—A statement of the amount due to this Society for subscription or other claims shall be sent to each life or ordinary member in the month of October in each year, and no member shall be entitled to exercise any privilege as such after the ensuing thirty-first day of December until he shall have paid his annual subscription.

XI.—A copy of this Rule shall be sent, with the foregoing statement, to every member whose subscription is in arrear for two years preceding the current year; and in case the subscription and arrears are not paid before the close of the year, such person shall then cease to be a member of the Society, but without prejudice to the right of the Society to recover such subscription and arrears.

XII.—Individuals distinguished for their Geological researches,

for their liberality to the Society, or for their connexion with other Societies, may, on the recommendation of the Council, be elected honorary or corresponding members of this Society at any ordinary or general meeting. But such honorary or corresponding members shall have no vote in the affairs of the Society.

XIII.—The Curators for the time being of the Manchester Natural History Society, of the Manchester Botanical Gardens, and the Salford Borough Royal Museum and Library, shall be *ex-officio* honorary members of this Society.

XIV.—Any member may withdraw from the Society by signifying his wish to do so, by letter under his hand, to the Secretaries, at the apartments of the Society; provided always, that such member shall be liable for the subscription for the whole year wherein he signifies his wish to withdraw; and shall continue liable to future annual subscriptions until he have discharged all sums due from him to the Society, and returned all books and other property, if any, in his custody, belonging to the Society; or shall have made full compensation for the same if lost or not forthcoming after two months' notice from the Secretaries.

XV.—An annual meeting shall be held on the last Thursday in the month of October, in each year, for the purpose of electing the officers for the current year, receiving the Annual Report of the Council, and conducting the general affairs of the Society.

XVI.—Ordinary meetings of the Society shall be held once, at least, in every month, from October to June, inclusive, at such time as the Council shall appoint. Each member shall have the power to introduce visitors to the meetings, on entering their names in a book to be kept for that purpose.

XVII.—Ordinary meetings may be held in other localities than

Manchester, according to the pleasure of the Society, to be determined at a previous meeting.

XVIII.—Circulars announcing meetings of the Society, or of the Council, shall be sent, free of postage, to the respective members of those bodies, at least three days before such meeting.

XIX.—Special general meetings may be summoned by the Council, or by the Secretaries, on the requisition, in writing, of any twelve members of the Society, by notice delivered free, or sent by post, pre-paid, to all the members whose addresses are known, not less than one week, nor more than a fortnight, before any such meetings. Such notice shall state the time and place of holding the meeting, and the specific purposes for which it is convened; and the business of such meeting shall be restricted to such purposes.

XX.—At the hour appointed for a meeting the chair shall be taken by the President, or the senior Vice-President present, and in their absence the meeting shall, previously to entering upon any other business, elect some member present to be Chairman.

XXI.—All questions discussed at any meeting, except as otherwise provided, shall be decided by a majority of votes; and if upon any question the votes shall be equal, the Chairman of the meeting shall have a second vote as a casting vote.

XXII.—Any meeting shall adjourn to a future day, if five of the ordinary or life members shall not in person assemble and proceed to business in half an hour from the time fixed for the meeting; or if that number shall not be personally present when the whole or any part of the business to be transacted shall be decided upon; and any meeting shall have full power to adjourn if it shall think proper; such adjourned meeting to be summoned in the same manner as the original meeting.

XXIII.—A President, four Vice-Presidents, two Secretaries, a Treasurer, and two Curators shall be elected at each annual meeting; and the foregoing, together with twelve ordinary members, to be elected at the same time, shall form the Council of the Society, and shall have the management of its affairs, except as is otherwise provided by these Rules.

XXIV.—All members who have been for six months members of the Society, and whose subscription is not in arrear, shall be eligible to be elected officers or members of the Council. The election of officers of the Council shall be conducted by ballot, among the members present.

XXV.—In the event of any vacancy occurring in the officers or Council, the same shall be filled up by the Council.

XXVI.—The President shall not be eligible for that office for more than two years in succession; and the two Vice-Presidents, and the four members of the Council who shall have attended the meetings of Council the least number of times, shall be ineligible to the same office for the ensuing year. In such computation of attendances, one attendance of a member resident five miles from the Exchange, in Manchester, shall be equal to two attendances of a resident within that distance.

XXVII.—The Council shall have power to make bye-laws and regulations, in accordance with the general Rules of the Society, to appoint, suspend, or dismiss salaried agents, clerks, or servants; to purchase and collect books, maps, models, specimens, and other objects, and to maintain and extend the museum.

XXVIII.—The Council shall meet once at least in every month, and upon such other occasions as they may deem expedient. Special meetings of the Council may be called by either of the

Secretaries, on the requisition of any three members of the Council, of which number the officer convening such meeting may be one; any three members of the Council present at a meeting being sufficient to constitute a quorum.

XXIX.—A minute of the proceedings at all meetings shall be entered by the Secretaries in a book to be kept for that purpose.

XXX.—The Council shall have power, with the consent of the author, to publish in a Journal of the Society's Transactions any paper or communication read before the Society, but the author shall be at liberty to reserve his right of property therein.

XXXI.—In pursuance of the arrangements made with the Manchester Natural History Society, the following shall be the regulations for the management of the Museum;—

The Museum, and all future additions thereto, shall be permanently united with the Geological Collection of the Manchester Natural History Society, so as to form one collection, which shall be deposited in the hall or building belonging to the latter Society, and shall be open gratuitously to the public, at such hours and on such days as the general Museum of the Natural History Society shall be open for the reception of visitors.

The management of the united Collection shall be vested in the two Curators of this Society, in conjunction with two Curators appointed by the Natural History Society; and such four Curators shall have power to exchange or give duplicate specimens if and when it shall appear to them desirable. But every such exchange or gift shall be reported by the Curators of this Society to the next meeting of the Council.

Subject to the preceding regulations, the admission to and all other arrangements respecting the united collection shall be under the management of the Council of the Natural History Society. At each annual meeting of the Manchester Geological Society, two

members of the Natural History Society shall be nominated to represent this Society on the Council of the Natural History Society. Any vacancy occurring during the current year in the members so representing this Society, shall be filled up by the Council until the next annual meeting.

XXXII.—The property of the Society shall be vested in twelve trustees; and when the number of the trustees shall by death or resignation, or other cause, be reduced to four, the vacancies shall be supplied by new trustees, to be elected at an annual or special meeting of the Society.

XXXIII.—Subject to the regulations respecting the museum, the trustees shall permit the Council for the time being to receive, manage, and direct the library, museum, and funds of the Society; but no gift, sale, or other disposition of the library or museum, or any part thereof (except as herein mentioned) shall be made unless with the consent of the members given in the same manner as is hereinafter directed with respect to the dissolution of the Society. Provided that in case of a dissolution of this Society during the existence of the Manchester Natural History Society, the interest of this Society in the museum or geological collection shall cease, and the entire collection and specimens shall become the property of the Manchester Natural History Society on that Society giving an undertaking to such parties as shall be named by the Manchester Geological Society, that such geological museum or collection shall be open gratuitously to the public.

XXXIV.—All the funds and moneys of the Society shall, during the subsistence thereof, be applied by or under the direction of the Council, in paying the debts and demands for the time being owing by the Society, and carrying out the purposes thereof as defined in the preceding rules; and no dividend, gift, division, or bonus in money shall at any time, or under any circumstances, be made unto or between the members of the Society, or any of them.

XXXV.—No additional rule, nor any alteration or repeal of any existing or future rule or rules of the Society shall be made, unless with the consent of three-fourths in number of such of the ordinary and life members as may be present at any annual or special meeting; and the proposed change must be announced by circular to the members whose addresses are known, a least three weeks before such meeting.

XXXVI.—The Society shall not be dissolved, nor shall the library or other property be disposed of, unless with the consent, in writing, of three-fourths of such of the ordinary and life members as may be present at each of two successive special general meetings, duly convened by public advertisement in all the Manchester newspapers, and by notice sent by post at least one calendar month before the meeting, to all members, whose addresses are known; such meetings to be held at an interval of not less than two, nor more than four, calendar months.

BYE-LAWS

FOR

REGULATION OF THE LIBRARY.

I.—No Book, Map, Newspaper, or document shall be taken from the Rooms of the Society without the same being first entered in a Register, in such manner as the Council shall from time to time direct.

II.—No Newspaper shall be taken from the Rooms till the second succeeding number has been received, except between the

hours of four in the evening and ten in the morning. And every such paper so taken out as last aforesaid, on one evening, shall be returned by half-past ten on the next morning, under the penalty of twopence for every half-hour elapsed after that time. Provided that it shall not be needful to return a Newspaper taken on Saturday evening before Monday morning.

III.—The Fine for not returning a Book, Map, Newspaper, or document shall be (except in the case provided for in the last rule) one shilling for every week completed while the Book is kept after it is due.

IV.—No Member shall be allowed to take out any Book, &c., till all his fines are paid.

V.—The times allowed for retaining a Book, &c., shall be—To Members living within five miles of the Manchester Exchange a fortnight—To other Members one calendar month.

VI.—No Member shall be allowed to take out more than two Volumes or two Maps, Newspapers, or documents, or one Volume and one Map, Newspaper, or document at one time.

VII.—No Member shall be allowed to renew a Volume, Map, &c., in case any other Member shall have entered his name as being desirous of taking out the same on its return. Such Volume, Map, &c., shall, on its return from the person holding the same, be entered as taken out by the Member so applying, and shall not be taken away from the rooms of the Society by any Member, save him in whose name it is entered, till the expiration of the period for which the Member in whose name it is entered would have been entitled to hold the same. At which period the said Book, &c., (in case the same shall not have been taken out by the party in whose name it is entered on the Register,) shall be marked in the Register as returned.

VIII.—The time allowed for holding shall, in every case, be computed from the date of the entry in the Register.

IX.—Every Member shall return the Books, Maps, Newspapers, and documents belonging to the Society in as good a condition as when they were delivered into his possession, and shall be answerable for the same till their return from him to the Society is correctly entered in the Register.

By order of the Council,

JOHN E. FORBES, } HONORARY
G. C. GREENWELL, } SECRETARIES.

Manchester, 1*st November*, 1864.

LIST OF MEMBERS.

The Names of Honorary Members are printed in *Italics*.

* Members who have compounded for the Annual Subscription.

Agassiz, Louis, M.D., Professor of Natural History, Cambridge, Massachusetts.

Aitken, John, Bacup.

Alcock, Thomas, M.D., Museum, Peter-street.

Ashworth, John, Rose Hill, near Bolton.

Ashworth, Thomas, Cheadle, near Stockport.

Atkinson, John J., Chilton Moor House, Fence Houses.

Babbington, Gisborne,

Baines, Henry, Clifton and Kearsley Collieries, near Manchester.

Baldwin, Thomas, civil engineer, Bury.

* Bannerman, Alexander, Chorley, Lancashire.

Barr, William Roby, F.G.S., Park Mills, Stockport.

Bazley, Thomas, M.P., Eynsham Hall, near Witney.

Bealey, R. R., Old Hall, Stand.

Bennett, Matthew, Moor Side House, Little Hulton, Bolton.

Beswicke, William, 20, Yorkshire-street, Rochdale.

Binney, E. W., F.R.S., F.G.S., 40, Cross-street.

Birkenhead, E. H., F.G.S., Mining School, Wigan.

Blackburne, J. G., F.G.S., mining engineer, Oldham.

Blackburne, William, mining engineer, Oldham.

Blomeley, Jonathan, 45, Exchange Arcade, Manchester.

Booth, Isaiah, F.G.S., Chamber Colliery, Hollinwood.

Bradbury, Charles, Dunkenhalgh Park Colliery, Accrington.

Bradbury, John, Clayton Colliery, Manchester.

Bramhall, Henry, Rainford Colliery, near St. Helens.

Brongniart, Adolphe, Professor of Botany, Jardin des Plantes, Paris.

Brooke, William, F.G.S., 112, Upper Brook-street, Chorlton-upon-Medlock.

Brooks, Thomas, Sunnyside, Rawtenstall.

Brown, John, F.G.S., Harborough House, Barnsley.

Bryham, William, Rose Bridge Colliery, Wigan.

* Buccleuch, Duke of, Whitehall Gardens, London.

Buckley, Edmund, Ducie-street, London Road.

Buckley, William, Limehurst Colliery, Ashton-under-Lyne.

Calvert, F. Crace, F.R.S., F.G.S., Bond-street, Manchester.

Charlton, F. P., jun., Bank House, Middle Hulton, Bolton.

Charlton, George, F.G.S., Estate and Mineral Office, Pontefract.

Chattwood, Joseph, Union Square, Bury.

Clarke, C. F., Colliery Viewer, Garswood, near Warrington.

Clayton, D. S., Norbury Moors, near Stockport.

Clough, Samuel.

Cooke, Rev. S. H., Great Budworth, Northwich.

Cooper, Thomas, Mossley House, near Congleton.

* Coulthart, J. Ross, F.R.S., Lit. Croft House, Ashton-under-Lyne.

Cross, John, mining engineer, Bury.

Cross, John, Gidlow House, Wigan.

Cunliffe, Ellis, 18, Princess-street, Manchester.

Darbishire, R. D., B.A., F.G.S., 21, Brown-street, Manchester

Darlington, James, Meriden Hall, Coventry.
Dearden, Richard, Darcy Lever, Bolton.
Dickinson, Joseph, F.G.S., Eccles Old Road, Pendleton.
Diggle, James, Westleigh Colliery, Leigh.
Dorning, Elias, 41, John Dalton-street, Manchester.

Eaton, Henry, Mount Zion, Radcliffe.
Edmondson, Robert, Royal Hotel, Bury.
* Egerton, Sir P. D. G., Bart., M.P., F.R.S., Oulton Park, Tarporley.
Egerton, The Hon. Algernon, M.P., Worsley Hall.
Embleton, S. W., Middleton Colliery, Leeds.
Enniskillen, Earl of, F.R.S., Florence Court, Fermanagh.
Eskrigge, R. A., Old Hall-street, Liverpool.

Fairbairn, William, D.C.L., F.R.S., The Polygon, Ardwick.
Fairbank, F. R., St. Mary's Terrace, Hulme.
Farrer, James, engineer, Bury.
Farrimond, T., civil and mining engineer, 61, Exchange Arcade.
Finlay, Bruce, Botanical Gardens, Manchester.
Fishwick, H., Carr Hill, near Rochdale.
Fletcher, John, Clifton House, near Manchester.
Forbes, John Edward, F.G.S., 3, Faulkner-street, Manchester.
Forster, George Baker, M.A., Backworth House, Newcastle-on-Tyne.
Fort, Richard, F.G.S., Read Hall, Whalley.

Gerard, Sir R. T., Bart., Garswood, near Warrington.

Gilroy, George, Ince Hall Colliery Wigan.
Goodwin, Joseph, mining engineer, Hyde.
Graham, Rev. Philip, Turncroft, Over Darwen.
Greg, Robert Hyde, F.G.S., Chancery Place, Manchester.
Greg, Robert Philips, F.G.S., Chancery Place, Manchester.
Greenwell, G. C., F.G.S., Poynton, near Stockport.

Hadfield, George, M.P., 34, Fountain-street, Manchester.
Hall, Robert, ironfounder, Bury.
Hall, Samuel, solicitor, Bacup.
Handley, Joseph, Bank-street, Bury.
Harbottle, W. H., Orrell Colliery, near Wigan.
Hardcastle, James, Firwood, near Bolton.
Hardwick, C., 100, City Road, Manchester.
Harrison, Thomas, mining engineer, Barnsley.
Harter, William, Hope Hall, Pendleton.
Harvey, William, Acton Square, Salford.
Hawksworth, E., Ladyshore Colliery, Little Lever, near Bolton.
Heelis, John, 37, Cross-street, Manchester.
Henderson, A. G., Green Mount Cottage, Harpurhey.
Hertz, James, Bond-street, Manchester.
Heywood, George, land and mine surveyor, Oldham.
* Heywood, James, F.R.S., Kensington Palace Gardens, London.
Heywood, Oliver, Acresfield, Manchester.
Heywood, Sir B., Bart., F.R.S., Claremont, Manchester.
Hewlett, Alfred, jun., Haigh Colliery, Wigan.
Hibbert, James, Bardsley Bridge Colliery, Ashton-under-Lyne.
* Higson, Peter, F.G.S., Cross-street, Manchester.
Hilton, Thomas W., mine surveyor, Woodlands, near Wigan.

Hodgson, James, consulting engineer, 7, Sweating-street. Liverpool.

Horsfall, J. J., Fairbottom Colliery, Ashton-under-Lyne.

Jackson, Henry, Bedford Lodge, Tyldesley, near Manchester.

Johnson, Richard, Dale-street, Manchester.

Joule, J. P., F.R.S., &c., Old Trafford.

Knowles, Andrew, High Bank House, Pendlebury.

Knowles, John, Temple Lodge, near Pendlebury.

Knowles, Thomas, Cliveley Bank, near Pendlebury.

Knowles, Kaye, Swinton House, near Pendlebury.

Knowles, Robert M., Eagley Bank, near Bolton.

Knowles, Thomas, Ince Collieries, Wigan.

Lacy, Edward, Buxton.

Lancaster, John, F.G.S., Kirkless Hall Colliery, Wigan.

Langton, William, Mosley-street, Manchester.

Leach, Saul W., Lower Moor, Oldham.

Lees, Abel, ironfounder, Bardsley, Ashton-under-Lyne.

Littler, William H., solicitor, Oldham.

Livesey, Thomas, Chamber Hall, Hollinwood.

Livesey, W. C., Bradford Colliery, Manchester.

Lyell, Sir Charles, Bart., D.C.L., F.R.S., &c., Harley-street, London.

Lynde, J. G., F.G.S., Town Hall, Manchester.

Manchester, Lord Bishop of, D.C.L., F.R.S., &c., Mauldeth Hall, Burnage.

Marshall, John S., solicitor, Wigan.
Mercer, John, Park Lane, near Wigan.
Middleton, J. S, Whalley Range, Manchester.
Mordacque, Rev. L. H., M.A., Parsonage, Haslingden.
Morton Charles, St. John's, Wakefield.
* Mosley, Sir Oswald, Bart., F.G.S., F.R.S., Rolleston Hall, Burton-on-Trent.
Moubert, Adolphus, Garswood, Warrington.
Murchison, Sir R. J., D.C.L., K.C.B., &c., 16, Belgrave-square, London.

Nesbitt, George, 52, George-street, Manchester.
Nuttall, Thomas, colliery surveyor, Bury.

Ormerod, H. M., Clarence-street, Manchester.

Park, James, ironfounder, Bury.
Parker, James, Museum, Peter Street, Manchester.
Peace, George, Lord's-Fields Colliery, Ashton-under-Lyne.
Philips, Mark, Snitterfield, Stratford-on-Avon.
Phillips, J., M.A., LL.D., F.R.S., &c., Museum House, Oxford.
Pickup, Peter, Townley Colliery, Burnley.
Pilkington, Thomas, York-street, Manchester.
Plant, John, F.G.S., Museum, Peel Park, Salford.

Readwin, Thomas A., F.G.S., Stretford.
Ridyard, John, Walkden, Worsley.

Roscoe, James, New Watergate, and Peel Hall, near Bolton.
Roscow, Joseph, Chadwick Hall Colliery, Rochdale.
* Ross, William, Leaf-square, Pendleton.

Satterfield, Joshua, Alderley Edge.
Seddon, Peter, Lower Moor Colliery, Oldham.
Seddon, William, Lower Moor Colliery, Oldham.
Sedgwick, Rev. A., M.A., LL.D., F.R.S., Trinity College, Cambridge.
Seymour, Martyn, Staveley Works, Chesterfield.
Shuttleworth, Sir James P. K., F.G.S., Bart., Gawthorpe Hall, Burnley.
Sleath, W. J., manufacturer, Bacup.
Smethurst, William, Anderton Hall Colliery, near Chorley.
Smith, G. S. Fereday, M.A., F.G.S., Swinton Park, Manchester
Smith, Richard, Little Green, Collyhurst, Manchester.
Sopwith Thomas, M.A., F.R.S., F.G.S., Cleveland Square, Hyde Park, London.
Spence, Peter, F.C.S., Newton Heath, Manchester.
Spencer, John, Rock Terrace, Crawshawbooth.
* Stanley, Right Hon. Lord, M.P., F.R.S., Knowsley, Prescot.
Statter, Thomas, Bury.
Stott, James, Basford Hall, Newcastle-under-Lyme.
Stewart, John, Dunkenhalgh Park Colliery, Accrington.
Swain, John, engineer, Hyde.

Taylor, John, Mercury Office, Norwich.
Taylor, John, jun., 2, Great Howard-street, Liverpool.
Taylor, William, Hazlehead Hall, Dunford Bridge, Yorkshire.
* Trafford, Sir Humphrey De, Bart., Trafford Park.
Turner, Thomas, F.R.C.S., 67, Mosley-street, Manchester.

Wadham, Edward, Millwood, Dalton, Furness.

* Walker, J. Reed, Calderstone, Allerton, Liverpool.

* Walsh, Eli, Heyfold Colliery, Over Darwen.

Webster, R. C., Ruabon Colliery, Ruabon, Wales.

Wheatley, Thomas Edward, Shudehill, Manchester.

Whewell, Rev., D.D., F.R.S., &c., &c., Trinity College, Cambridge.

Whitehead, Thomas Lees, mining engineer, Rochdale.

Whitehead, T. B., Oakley Terrace, Rawtenstall.

Wild, James, Dean-house, Rochdale.

Wild, John, Glodwick, Oldham.

Wild Samuel, Dean-house, Buersill, Rochdale.

Wilding, William, 10, Acres Field, Bolton.

Wilson, Thomas Banks, Crimble House, Leeds.

Winstanley, Robert, 91, Cross-street, Manchester.

Wood, Henry, M.P., The Larches, Wigan.

Wood, Thomas, Kersal Lodge, Higher Broughton.

Worthington, Robert, F.R.A.S., King-street, Manchester.

Wynne Thomas, F.G.S., M. Institute, Field-house, Stone, Staffordshire.

Yates, James, M.A., F.L.S., G.S., Lauderdale House, London.

Young, Edward, St. David's Fire Brick Works, Oughty Bridge, Sheffield.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 2.] VOL. V. [Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter-street, on Tuesday afternoon, Nov. 29th, 1864.

ANDREW KNOWLES, ESQ., President, in the Chair.

Mr. Andrew Knowles, the newly-elected President, upon taking the chair, said he begged to take the opportunity of returning his sincere thanks to the Society for electing him a second time to be their President. All that he could do was to reiterate what he had said at the commencement of last session, that he would do everything he possibly could to serve the interests of the Society.

A fine specimen of what was apparently the Pelvis of a Deer was exhibited. It was found about ten feet deep in a bed of clay in the neighbourhood of Radcliffe, about 2½ miles from Bury. The precise spot was sufficiently near the river to warrant the belief that in some ancient time it was dropped at the water by some beast of prey coming to the water to drink.

Mr. Heap, in reply to a question, said the specimen was found near Radcliffe old tower, and in a part where no doubt the river once flowed.

Mr. Binney said it was probably taken from a valley gravel, and not from that kind of clay of which bricks were made. No doubt the specimen was a pelvis of some kind: it had been suggested it was that of a stag. It was well known that red deer remains were very often found in such deposits. Some were taken from further up the valley, near Haslingden. Probably the whole animal would have been found in the same place if a search had been made. The present specimen was in an excellent state of preservation.

The following paper was then read:—

MANCHESTER GEOLOGICAL SOCIETY'S EXCURSION TO LLANGOLLEN.

By John E. Forbes, F.G.S.

The annual summer field meeting of our members and friends was held at Llangollen on the 14th and 15th July last; where it was arranged we should be joined by the Liverpool Geological Society and the Dudley and Midland Geological Society and Field Club. About twenty of our members took advantage of the occasion, and the majority left Manchester by early train on Thursday morning. On arrival at Llangollen, after refreshment the party commenced their examination of the geological features of the northern side of the valley, and proceeded for upwards of a mile along the banks of the river Dee to the slate and flag works near Llantysilio, where the first halt was made.

With much courtesy the manager conducted the party through the works, where they saw the machinery and various appliances by which the huge slabs, brought from the quarries near the summit of the adjoining hills, are prepared and fashioned into shape for the various industrial and ornamental purposes for which they are so largely in demand.

The next point of interest was the venerable pile of ruins, all that now remains of Valle Crucis Abbey, which was at one time a famous monastic establishment, built about the year A.D. 1200, and must have been amongst the earliest specimens of pure Gothic architecture in Great Britain.

At this point the party divided. One portion under the guidance of Mr. Bickerstaffe, of Llangollen, proceeded to collect the flowering and other plants of the district; the remainder, taking a path across the hills, came to the remarkable expanse of mountain limestone in the Eglwseg rocks. This locality is very interesting, on account of there being beds of red marl cropping out from under the base of the limestone, and said to represent the old red sandstone. The hill of the Castell Dinas Bran was next ascended; and, on their return, the party sat down to a collation provided at the Hand Hotel; and the first day's scientific proceedings concluded by an interesting description of the geology of the surrounding district which the party had visited.

On the second day, Friday, a party of about thirty, including a few ladies, started at 9 o'clock in the morning, under the guidance of Mr. D. C. Davies, of Oswestry. The day's work commenced by ascending the steep hills towards Llansantfraid. It was exceedingly hot, and, after many rests, the slope above the river Ceiriog was reached. From this point a few of the party descended the hills to the New Inn, at Llansantfraid, and explored the geological features of the neighbourhood, and witnessed the interesting process of sizing and trimming the slates for roofing, &c. in a neighbouring quarry. The others, taking a longer route to the same destination, proceeded on the road to Nantyr, towards Cefn Coed, where, leaving the upper silurian rocks behind, they first employed their hammers and chisels on the uppermost beds of the Bala group of North Wales. On this route the structure of the Trappean

Ash is beautifully exhibited; and the third and lowest band of Bala limestone is characteristically exposed in the romantic valley of the river Deiriew.

The Felspathic Ash beds came also under notice, and many interesting sections of the various strata were carefully examined.

On the table some of the specimens obtained are laid before you for inspection.

The evening now fast drawing to a close, all returned to the morning's starting place, and the majority took train homewards; the remainder, taking advantage of the beautiful weather, stayed a few days longer; and pleasing recollections of its objects of interest and splendid scenery will long be retained by those who availed themselves of this excursion to the Vale of Llangollen.

The thanks of the Society were unanimously voted to Mr. Forbes for his Paper.

Mr. Binney said it was a very trying thing for the Secretaries to get up excursions unless the members exerted themselves to attend. At the excursion to Llangollen the Manchester geologists were but a small number compared with those of Dudley.

Mr. Plant said it would be highly advantageous if the Society got up several excursions of this kind, because it enabled the members in company to inspect the geology of a particular locality, and to procure reliable data upon which to make comparisons. He had a number of specimens some of which differed from those which Mr. Forbes had laid upon the table, but they only differed as upper silurian fossils differed from the lower.

Mr. Binney said these fossils were named at the commencement of this Society. My friend the late Mr. Bowman investigated them, and he was the first man to describe the lower silurian fossils of North Wales; and the collection in the Society's museum was gathered from this district. It was when collecting these fossils that Mr. Bowman took cold and died. A full account of his investigations would be found in the first volume of the Society's Transactions.

Mr. R. A. Eskrigge—It is a pity the Society did not visit the flagstone quarries themselves, instead of stopping short at the workshop where the flags are dressed, for they would have found there a most interesting section of the Wenlock shales. The strata are almost vertical, and are quarried in huge slabs, by working underneath and then detaching them by levers. The fossils are not numerous specifically, although a few species occur abundantly, viz.:—*Cardiola interrupta*, *Orthoceras primævum*, and, more rarely, a long stemmed and beautiful *Encrinite*, *Actinocrinus pulcher*. The shale is gritty, and of a dark blue colour, and it is interesting and instructive to notice the difference in lithological character from the shale of the same formation in Shropshire, at Buildwas and Wenlock, for instance, where it is fine and aluminous, of a light grey colour. During a recent visit to the neighbourhood of Settle, in Yorkshire, in company with some members of this Society, in passing along the valley between Littleborough and Pen-y-Ghent, I noticed a rock of precisely similar lithological character to that of the flagstone quarries at Llangollen; and, upon examination, I found the fossils identical, with the addition, however, of a large number of *Graptolites*. Following the same valley to the village of Horton, at the foot of Pen-y-Ghent, there occurs a most interesting example of unconformability — the mountain limestone lying horizontally on the upturned edges of the Wenlock shales. The point of junction is so clear that you can stick your finger into the fissure

between them. Ascending the hill from this point, you pass in succession, representatives of all the lower carboniferous series, until you reach the millstone grit, on the summit. And exactly the same series occur on Ingleborough.

Mr. Binney said at Ingleton and Kirby Lonsdale there were beautiful sections, and fine scenery, and the Society could not do better than have its next excursion there.

The following Paper was then read:—

ON THE

SOUTH EASTERN PORTION OF THE SOMERSETSHIRE COAL-FIELD:

By G. C. Greenwell, F.G.S.

If we except the district now referred to, we have in all of the English coal-fields which have come under my observation, the various coal-seams lying parallel with each other or nearly so; and although the rate of inclination varies greatly in one locality from what it does in another, in the same coal-field, yet the change is rarely sudden, the dip becoming greater or less by degrees; the change being apparently due to prolonged, and not to sudden agency. In some coal-fields on the continent, we find the same peculiarities which we find in the coal-field to which our attention is directed, and from an examination of the Belgian coal-field, in the neighbourhood of Mons, as well as from a tolerably intimate acquaintance with that of Somersetshire, I am drawn to the conclusion that these coal-fields belong to the same period of the formation of coal, and that these contortions, from their similarity, are attributable to the same cause.

It has, I believe, been suggested that the coal-field of Liege and

Mons probably extends westward to England, and if this should prove to be the case, the above similarity might indicate a belt of coal-field from east to west, traversing the whole of the southern counties of England, lying between the Straits of Dover and the British Channel.

I have before me a section of the coal-mines of the Belgian coal-field, near Wasmes, where the shaft passes through the same seams of coal twice; and I have also before me a section of a colliery situated in the district, the subject of this paper, where a shaft might pass through the same seam of coal thrice.

The above is not the only point of similarity between the Belgian and the Somersetshire coal-fields; they both lie on the north side of belts of mountain limestone, and it is, when near to the limestone, in both cases, that the lowest seams, rising to the day from the bottom of the basins, exhibit the distortions referred to. In both localities these seams of coal are of a similar character, being generally soft, pure, and bituminous, and infested with fire-damp. And in both localities, northward from these steep and contorted measures, are seams of coal, comparatively flat and free from fire-damp, which, although lying at a considerable depth, are yet some thousands of feet above the seams first-named, which, when necessity demands, will no doubt be sunk to, and in all probability found in the greatest perfection.

I need not say anything about the difficulty of working coal when found in this abnormal state; it will be easily seen that it is next to an impossibility to lay out works with any view to permanent arrangement; and, in many cases, the seams of coal being inverted, and the usually soft underclay becoming the roof, the expense of supporting it is very great, and keeping the coal clean and free from dirt, exceedingly difficult. The distortion of the seams of coal near the Mendips, cannot be better shewn than by the following

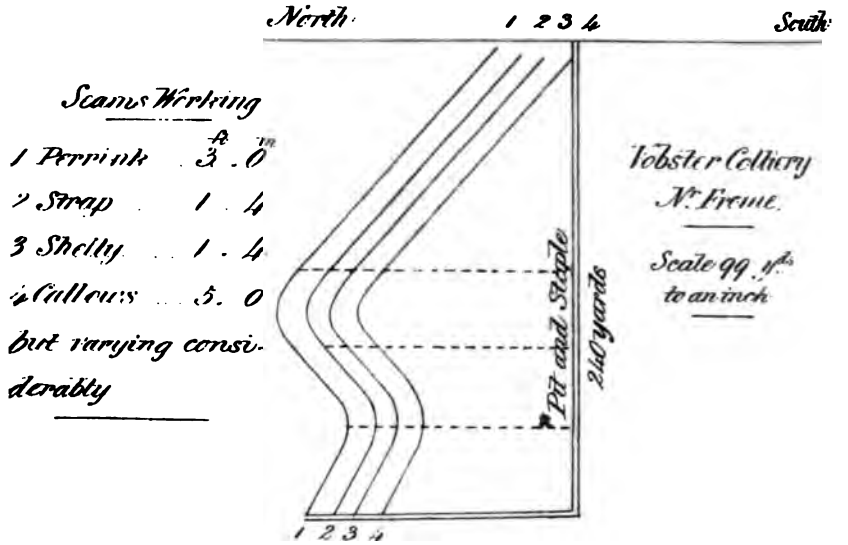
extract from Messrs. Buckland & Conybeare's observations on th south western coal district of England. (*Transactions Geologic Society of London*, 1824.)—At Goodeaves pit, from the Bailiff, M Jeffries. "The dip in general is southerly but sometimes it becom northerly. The beds are sometimes vertical, but never continue above 10 fathoms. The line of bearing is N.E. and S.W. as it is Newbury. Faults are frequent, which throw up the measures c the northern side." That these distortions have been coincide with the upheaval of the mountain limestone, is, I think, b slightly to be doubted; but if any further corroboration we required, the following fact may probably be considered conclusiv

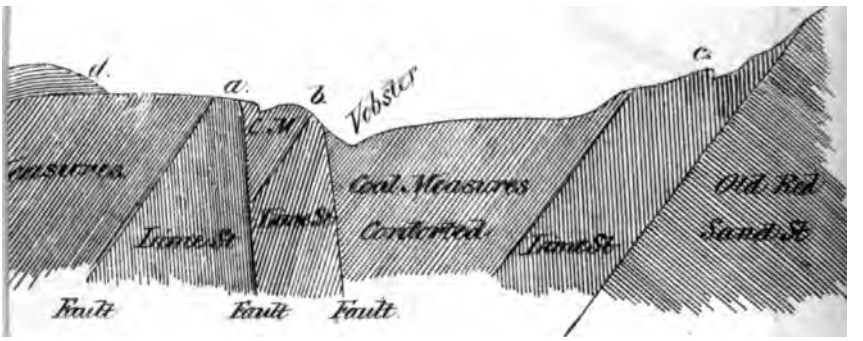
There is at a place called Upper Vobster, half a mile north of th mountain limestone proper, an outlier of limestone, until recent supposed to be the effect of faults of very great magnitude. Thi are shewn thus in the section accompanying the paper, abo referred to. That this explanation of the limestone being found *a* and *b* is inaccurate, is proved by the fact of the coal having be worked *under it*. And we are therefore led to conclude that wh the upheaval of the limestone took place, it was turned ov together with the coal-measures, and that if any of it covered th space between *b* and *c*, it has since been removed by denudatio This portion of the coal-field is now being further, and indeed som what extensively, developed; and many circumstances, which a now involved in obscurity, will no doubt soon be satisfacto explained.

In April of the present year, having heard that somewhere in th neighbourhood of *c*, on the last section, a fissure had been di covered by Mr. Moore, of Bath, containing some fish bones a teeth, Mr. Mc. Murtrie, of Radstock, and I went to Whatley to s if we could find the place, but we did not succeed. I have, ho ever, recently heard from Mr. Mc. Murtrie that somewhere about th place, he has been successful, and discovered fish remains in fissure in the mountain limestone. Some of these resemble palat

Callenus

Somersetshire Coal Field.





teeth of *Orodus*, being similar to that figured in the 2nd Volume of Buckland's Bridgewater Treatise, *plate* 41, *b*2; and there are also *Vertebræ*, and teeth resembling those of *Megalichthys* or *Holoptychius*. I need not say that this very interesting discovery well deserves further prosecution.

On referring to the section last given, it will be observed that the oolite (inferior) is lying immediately superimposed on the coal-measures. This fact has been proved by the sinking of a coal-pit about the point *d*, but what exact belt of oolite is here passed through, is by no means conclusively established. The specimen produced was taken by me from the sinking, and I am very much inclined to think that it is from the cornbrash or forest marble, in which case we are having the upper formations of England brought into closer proximity with the coal-measures than most people are aware of. At Braysdown Colliery, which is only four miles north of the coal-pit near *d*, we have—

	fms.	ft.	in.
Inferior oolite	4	0	0
Lias, marl, and limestone	19	1	0
New red sandstone	26	3	9
Conglomerate	2	3	0
	52	1	9

or upwards of three hundred feet of strata, including the whole, at least, of the lias and new red sandstone, which, if they ever existed at *a*, were denuded before the oolitic deposit was placed there; and it may be a question as to whether, in addition to the above, the inferior and great oolites have not, if they were ever present here, been swept away as well. So far, at any rate, as I have seen or heard, there is no great oolite between Braysdown and the point *a*, nor yet between the point *a* and Frome or Westbury; at the former of which places we have, I suppose, unquestionably the cornbrash, and at the latter the coral-rag, green sands and chalk. It is then, to say the least, probable, that should the coal-measures continue

eastward from the district under notice, a circumstance which I do not as yet see any reason to doubt or think unlikely, they may be sunk to without having to pass through the formation of oolite, lias, and red sandstone, which in other parts of England are found of such great thickness. Far away to the south of this district, in the island of Alderney, there are strata, which, if not millstone grit, are uncommonly like it, and these are beyond those upper formations which hem in our most southerly coal-field, and which have always been considered to interpose an insuperable barrier to the working of coal beneath, if in existence.

The thanks of the Society were given to Mr. Greenwell for his Paper.

Mr. Binney—I think this communication, though not a very long one, is exceedingly interesting; and it is one that it is very useful for a Society like this to discuss. The facts that Mr. Greenwell lays before us are of great value. Everyone who studies geology in a particular district is very apt to convey his ideas and impressions to a distance, and if he does not take care, he will wish to find exactly the same phenomena in a strange place as he has been accustomed to at home. Now if a man who is in the habit of looking at the trias, permian, and upper carboniferous beds in Lancashire, were to go down into Somersetshire and expect to find such an enormous mass of red sandstone and clays as we have here, and such a mass of red marls as are found in Cheshire, over the middle coal-field, he will be mistaken. He must be prepared to take the sections as he finds them. At the meeting of the Bath Association, I went to Whatley to see where Mr. Moore obtained his wonderful amount of specimens in the crevices of the limestone. If I remember right he took out some millions of teeth, which he washed carefully. They were in fissures in the limestone, mixed

with mud. In one place we saw the mountain limestone there, covered up with oolite, where there are no coal-measures at all. I think the remarks which Mr. Greenwell has made of the coal-field of Somersetshire extending under the south-east of England and joining that of Belgium is a very probable hypothesis. In the north of France they pass through the chalk into coal-measures. It is singular that the strange contortions in the coal-measures of Somersetshire should so much resemble those of Belgium. In sinking through them sometimes you get the same seam of coal twice over, and that is a state of things we very seldom see here. In the north-west of England the coal-measures vary very much as well as in the south. There are several thousand feet of coal-measures without coal at all in the south-west of Scotland—nothing but a few fossils. We have our Ardwick limestones in the south of Scotland, and no seam of coal about them, while in this neighbourhood we have three and four seams in and under them.

Mr. Plant—Do I understand that the small specimens of fish teeth have been taken from the mountain limestones?

Mr. Greenwell—Yes, from a fissure.

Mr. Plant said it appeared to him that they had not the true Palæozoic characters, which are so readily distinguishable. The fissure had probably been filled up with the infiltration from the oolites above.

Mr. Binney said it had not been contended that they were Palæozoic fossils. They had tumbled into the fissures in which they were found.

The President—How would Mr. Greenwell account for the outcrops of the coal-measures not having been discovered in southern counties before now?

Mr. Greenwell said the working of coal had been of very ancient date in Somersetshire.

The President—Then the conclusion you have arrived at is that the coal-measures of Somersetshire dip down and come out again upon the continent?

Mr. Greenwell—I put it forward as a mere speculation. The data I have produced were given me by the engineer of a colliery in Belgium, and were taken from actual measurement, as traced on the working plans.

The President—All the coal-mines in Somersetshire that have been proved are, I believe, of the lower mines. There are none, I think, of the higher series. They are all the mountain mine series.

Mr. Greenwell—They are all above the millstone grit.

Mr. Binney—There is no doubt the coal is equal to the coal you get at Clifton. There is nothing to place them in our lower coal-fields. Those that I saw appeared like fossil middle coals. I myself should call the whole of the Somersetshire coal-seams as equivalent to our thick coals. The coal-field is remarkably destitute of fossil shells.

This closed the discussion; and after a vote of thanks had been passed to the President, the proceedings terminated.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 3.] VOL. V. [Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter-street, on Tuesday afternoon, Dec. 20th, 1864.

ANDREW KNOWLES, ESQ., President, in the Chair.

Mr. R. M. Knowles exhibited a specimen of *pyrites*, which he said was found in the gravel about a mile from the estate of Baron Rothschild, in Buckinghamshire.

Mr. E. W. Binney said it was a beautiful specimen of the radiated iron *pyrites*.

Mr. Joseph Dickinson (the ex-president) said this was one of the best possible illustrations that the rounded form was given to these specimens by crystallization, and not by attrition, or rolling. There was abundant evidence of this in the clearly marked section. The crystallization here was as perfect as that in any met with; and the lines all radiated beautifully from the centre.

Mr. Binney said no doubt the specimen was spherical at the time of its formation, but these specimens would bear a great deal of rolling without being much altered in shape.

Mr. Plant said these specimens were very plentiful in Suffolk, where they were collected in cartloads for sulphur making, and termed potato-stones. He quite agreed with Mr. Dickinson that the marks were due to crystallization, and not in the slightest degree to rolling.

Mr. Plant exhibited a series of animal remains, in very perfect preservation. He said,—I have here some important bones of the elephant, rhinoceros, and hippopotamus, which have been found in Staffordshire. I am not in full possession of their proper history, as they came to me with a collection of other things. A portion of them, however, are ticketed that they have been found in Staffordshire, and I am trying to get all the particulars as to their history, and the exact locality whence they came. One specimen is part of a shoulder blade; another is a portion of the upper part of the tibia; another is what is generally called the knee-cap; and there is also a portion of a smaller bone, which I believe belongs to the shoulder. These are all elephant remains; but with them is a portion of the large tooth of Professor Owen's great fossil hippopotamus, *(Hippopotamus major)*; it had a tooth twice the size of any living species. There are two other portions which have been fractured, and the pieces therefore do not fit. In addition to these there are two teeth belonging to the *Rhinoceros tichorhinus* of Professor Owen, and their characteristics cannot be mistaken. There is likewise the wrist bone of a fossil horse, which is not an unusual bone found in drift deposits. Also the tooth of an ox and horse, and four fragments which evidently belong to the antlers of a deer. Plot (the oldest Staffordshire historian, *anno* 1088), in his natural history of Staffordshire, relates that a jaw and tooth of a young elephant were found in a marl pit on the estate of W. Levison Gower, near Trentham; and he indulges in a speculation, that the elephant must have belonged to one of the powerful British rulers in ancient times, or was brought over by the Romans, and, dying, found its burial place

in Staffordshire. Garner, in his Natural History of Staffordshire, mentions especially that the bones and teeth of the rhinoceros and elephant have occasionally been found in Staffordshire, at Trentham and other places, probably in diluvial gravel; and that in diluvial clay, found at the bottom of certain caverns in the limestones of Staffordshire, the bones of the red deer and roebuck are found. These are commonly associated with the bones of the rhinoceros, elephant, and hyena. Parkinson and Buckland both mention the finding of the teeth of the mammoth or elephant in the drift in Staffordshire; and Professor Owen, in his work on the Fossil Mammalia of Great Britain, quotes from these authorities on the evidences of the elephant in Staffordshire. I have heard it mentioned that at another Society in Manchester some bones were exhibited, which were recently found in Staffordshire. It is just possible that they belonged to the same elephant from which these I have laid before the meeting were derived.

Mr. Binney—At the last meeting of the Manchester Literary and Philosophical Society, Mr. Brockbank exhibited a very splendid series of remains of an elephant, which was no doubt a very large one. They were found at a place called Waterhouses, on the border of Staffordshire, in a fissure in the limestone. The whole of the elephant no doubt had been in that fissure, but how it got there, there is really no conjecturing. Mr. Brockbank said he never heard of such a thing being found in Derbyshire; but remains of the elephant have been found both in Derbyshire and Cheshire. Mr. White Watson, F.L.S., stated that 100 years before his time an elephant's remains were found at Ballaye, near Wirksworth, Derbyshire, in a crevice of the limestone. The teeth were plainly those of an elephant, but the people of the neighbourhood said that the brain pan, which held a bushel or two of corn, was that of a giant. Subsequent examination proved that it was not that of a giant, but of an elephant. The late Mr. Francis Looney, F.G.S., gives evidence of finding the molar tooth of an elephant

in Bollington, near Macclesfield; and in the early days of this Society, Mr. James Meadows brought us a fine portion of an elephant's tusk, found at Doveholes, near Chapel-en-le-Frith. In that case probably the whole of the elephant had been there, but the tusk had alone remained, while the rest had been decomposed. It is true that the remains of the elephant are much rarer in this district than on the east side of England. I have not myself seen any remains of the rhinoceros, or the hippopotamus. The bones which came from Waterhouses, to which I referred just now, were very soft and friable, while these upon the table are wonderfully hard.

Mr. Dickinson said that the fact of the remains being found in clefts in the rock would indicate that the animal had tumbled into it.

Mr. Plant said that in Leicestershire it was a very common thing to find elephants' teeth in the drift deposits and river gravel. In November, 1863, part of a remarkably fine tusk, nine feet long and two feet round, which must have been, when whole, about sixteen feet long, was found under eleven feet of sandy gravel.

Mr. Dickinson said that was a very different thing from being found deposited in the drift of the country.

The following paper was then read:—

ON THE PLIOCENE AND POST-PLIOCENE DEPOSITS IN THE NEIGHBOURHOOD OF NORWICH;

By John Taylor.

A residence of twelve months in the neighbourhood of Norwich,

and an assiduous attention to the superficial and crag deposits which abound here, have furnished me with the following notes :—

The geology of the crag has already been developed by several local geologists, among whom Woodward, Gunn, and King, may be named. The fauna of the crag have also occupied the attention of the Palæontographical Society, and two magnificent volumes have been published on this subject.

After stating these facts, it may seem presumptuous in me to take up the subject again, especially when the able geologists who have written upon it are taken into consideration. The few remarks which I shall venture, however, will be based upon the *physical* characters of the Norwich crag, rather than the palæontological, and will comprehend such facts as have passed under my own notice.

The extent and contour of the crag are already known. It is, however, far from being continuous. Usually it is found resting upon the chalk, and not unfrequently, as at Bramerton, about four miles from Norwich, the surface of the chalk upon which the crag rests has been bored into by molluscs or annelids. The occurrence of the crag is so arbitrary, that, in the distance of a few hundred yards, the various chalk pits will not only witness a change in its thickness, but in one, the crag will be altogether absent, whilst in another, it is present in its full development. Thus at Thorpe, near the Asylum, there is a rich bed of crag. At Postwick, although crag is found, it does not rest upon the chalk as in the former instance. At Bramerton, the crag lies in its usual position on the chalk; the distance between the first and the last places is about two miles, and Postwick is nearly equi-distant. The crag obtains its finest development at Bramerton, where it is about four feet in thickness, and is composed of millions of marine shells. At Thorpe it varies from a foot in thickness to eighteen inches. At Whitlingham, on the other side of the river, the crag rests on the chalk, but

is only about six inches in thickness. At Trowse, nearer Norwich, the crag is much thicker, being about two feet. In the chalk-pits, close to the city, little or no crag is found. At St. James' Hill, there is a thin and irregular seam, which is, however, very poor in shells. Going northward, we again meet with the crag at Wroxham, about eight miles distant from Norwich, and various other places.

The reason of this irregularity, it is not difficult to guess at. There is no doubt that the Norwich crag originally extended, in a bed of more or less variable thickness, from Suffolk to beyond Wroxham, in Norfolk. The friable nature of the bed would cause its denudation to be both extensive and easily brought about. On the uprising of the shallow sea-bottom, or estuary, on which the crag was formed, the shelly material would be scooped out irregularly by the action of currents, whilst the more elevated portions would be the first to suffer. Thus in the more sheltered hollows only would the crag be best preserved, and hence results its irregularity and absence. To employ an easily understood illustration: suppose a bagatelle-table, with its nine holes, was to be filled up with some material to the edges; afterwards let the whole surface, thus made level, be wrought upon with a carpenter's plane until the tool had reached the green baize cloth; the holes would still remain filled with material employed, although it had been cut away from the other parts of the table. Now, what the holes are to the table, the hollows on the uneven bottom of the crag sea were to the general surface. When the planing, or denuding process took place, the higher and more exposed portions of the crag would be removed. I know of no other way of accounting for the arbitrary occurrence of the Norwich crag. That great denudation has taken place subsequent to its deposition is proved by repeated occurrence of re-deposited crag higher up in the superficial or drift deposits.

At Trowse and at Bramerton, resting in the uneven and denuded hollows of the chalk, is a thick bed of laminated clay. This bed is

quite full of *Mytilus*, generally with both valves attached, and encrusted with *balani*, as if the creatures which once inhabited them had lived and died in the muddy sediments. *Tellina*, with both valves attached, are also occasionally found in the same state. Here and there this clay is capped with four or five inches of soft sand, in which lie hosts of *Mya arenaria*, generally in a position perpendicular to the stratification, as if the shells had originally rested in that position, as it is known the common *myas* of our muddy and sandy coasts do, and as is also the habit of the common *anodons* of our rivers and ponds.

The occurrence of fresh-water shells among the myriads of their marine congeners, indicates that the sea in which the crag was formed had a communication with a river. *Paludina lenta* is the commonest fresh-water shell thus found, and is frequent at Thorpe and Bramerton. The thousands of marine shells thus aggregated bear all the evidences of marine habits which may be witnessed in the molluscs of our own shores. The *Trochi* are de-turbinated, just as shells of the same genus are in our shallow sea-pools, by the action of acid. *Mytilus*, *Fusus*, *Astarte*, *Littorina*, *Purpura*, *Mactra*, *Tellina*, *Natica*, and others, are found in all the several stages of individual growth. The crag in question has thus slowly grown to its present thickness by the gradual accumulation of shells, which died at every stage of molluscan life. Such shells as the *Natica*, *Tellina*, and *Mactra* are bored with neatly drilled holes, showing that they were preyed upon by their carnivorous neighbours.

From the Norwich crag I turn to the deposits which everywhere overlie it. These are usually looked upon as being the analogues of the northern drift formation. They are, however, characteristically different, and, although they evince signs of glacial origin, they have at the same time peculiarities strikingly different from the drift deposits in the neighbourhood of Manchester. These Norwich

drift beds have little or no fauna of their own. They are usually rich in fragments of shells, but these belong chiefly to the underlying crag, from which they have been denuded. In general terms the superficial beds may be stated as follows:—

VALLEY GRAVELS,
UPPER SANDS,
UPPER BRICK EARTH,
MIDDLE SANDS,
LOWER BRICK EARTH,
LOWER SANDS.

Beginning then with "Valley Gravels." These consist almost exclusively of rounded flint boulders and nodules, very little water-worn, and evidently derived from the underlying chalk, at a spot not far distant from the present site. They are shown to greatest advantage on Mousehold Heath, about a mile and a half from Norwich. In the gravel pits of Mr. Moore, they are found irregularly stratified, and attaining their finest development. It is to the hard mineral character of these gravel masses that Mousehold Heath owes its irregular wildness, and which make it so different in scenery from the level plains beneath. Whilst the lower sands have suffered, the conglomerate character of the valley gravels has resisted the denuding agencies. In one of Mr. Moore's pits, these gravels may be seen abutting on, and filling up a hollow in the underlying sands. These gravels sometimes evince signs of fresh-water origin. Sometimes the upper part of the gravel passes into a sort of coarse brick-earth, which has evidently been derived from the underlying beds. At Thorpe, in a bluff of this material, I had the good fortune to hit upon a seam of fresh-water shells. The seam was about two inches in thickness, and was filled in with a black material, evidently the vegetable mud of a quite fresh-water deposit. Through the assistance of Mr. Reeve, the Curator of the Norwich Museum, the following species of fresh-water and land shells were identified.—

Bithinia	*tentaculata,*	*Planorbis*	*vortex,*
,,	*ventricosa,*	,,	*contortus,*
Valvata	*piscinalis,*	*Cyclas*	*cornea,*
,,	*cristata,*	,,	*calyculata,*
Limnæus	*pereger,*	*Succinea*	*pfeiffeiri,*
,,	*palustris,*	*Helix*	*depilata,*
Physa	*fontinalis,*	,,	*pulchella,*
Planorbis	*corneus,*	*Zonites*	*cellarius,*
,,	*marginatus,*	*Zua*	*lubrica.*
,,	*carinatus,*		

These shells leave no doubt of some of the fluviatile conditions of the deposits in which they were found.

Upper Sands.—The upper sands may be seen behind the Barracks, and also on Household Heath, in the pit belonging to Mr. Moore, already alluded to; these fine sands contain fragments of marine shells, and occasionally the workmen disinter entire specimens of *Purpura lapillus*. These, however, seem to have been washed out of the shell-bearing crag.

Upper Brick Earth.—The upper brick earth, or boulder clay, as it is called, may be studied to advantage on St. James' Hill, near Norwich, where it is several feet in thickness. It has suffered sorely by denudation, and is usually found capping the summits of the higher grounds in the neighbourhood of Norwich. It can scarcely be called boulder clay, inasmuch as when it is compared with that deposit in the neighbourhood of Manchester, it is found to contain a mixture of fifty per cent. more sand than the latter. It is, however, used for brick-making, although the amount of silica which it contains necessitates the burning of far more coal than is used in the north.

Middle Sands.—These beds seem to have been formed along the inclined bottom of the sea. They are found developed on St. James'

Hill, but reach their greatest thickness in a pit about a mile from Norwich, on the Ipswich Road, called the "Pinewood." Here these sands are exceedingly fine and of a marine-looking character. The upper brick earth caps the sand, and is about six feet in thickness. Fragments of *Cardium edule*, *Mactra*, and *Tellina* are plentifully interspersed through the sands. I tested some of the sand with hydrochloric acid and it effervesced very strongly. I should think that sands contain, at least, twenty per cent. of carbonate of lime, these derived from the underlying chalk. Mr. Kitton was kind enough to examine a portion of this sand under the microscope, and identified the following animalculic remains in it:—*Miliolina*, *Rotalina*, *Globigerina bulloides*, *Textularia*, *Orbulina universa*, (?) *Nummulina*. These foraminifera were very sorely water-worn, and all belong to to the chalk formation, with the exception of the last, which has probably come from the London clay. Besides there were fragments of *echinus* spines, &c., all testifying to the abrasion of the chalk. The brick-earth which rests upon these sands contains nodules of chalk, or chalk boulders, as well as septaria from the London clay. The most singular occurrence at this pit, however, is the fact of the middle sands passing into a hard, siliceous rock, regularly bedded and stratified. This bed can be traced in the passage state, from the loose sands, to a rock so hard that it is with difficulty broken with a hammer. The Rev. John Gunn, F.G.S., tells me that he is acquainted with a similar instance of these sands being consolidated near Yarmouth. This deposit of sand seems to thin away in a north-easterly direction. Near Magdalen Chapel, on the Wroxham Road, this sand is only about five feet in thickness, and separates the upper and lower brick earths. This sand bed bears all the signs of shallower water deposition. It is current-bedded, and contains great quantitites of carbonaceous mottlings, perhaps the remains of marine algæ now decomposed into this form.

Lower Brick Earth.—This bed, near Magdalen Chapel, contains great quantities of comminuted crag and other shells. It is very much

like, in appearance, the bed of brick earth overlying the middle sands. Its upper surface is very much denuded, and the sands fill up the hollows. This betokens its exposure for some time to abrading influences, prior to the deposition of the sands now lying upon it.

Lower Sands.—These may be seen at Thorpe, where they are only about two feet in thickness; at Postwick, where there frequently occur seams and "pockets" of re-deposited crag. The crag being chiefly composed *Littorina*, *Purpura*, and other shells whose strength of material enabled them to resist the wear and tear to which they must have been exposed. At Postwick there occurs in this sand a seam of Crag, containing scarcely anything else but *Cyprina islandica* aud *Mya arenaria*. Overlying the true Crag at Bramerton these sands are again visible, and contain many of the stouter shells, such as *Mya*, *Mactra*, and *Astarte*.

Such is a brief outline of the superficial deposits occurring hereabouts. When compared with the beds in the neighbourhood of Manchester, a marked difference is visible. The latter are rich in pebbles of foreign origin. In fact, I scarcely know of a better place to study the various rocks than the Lancashire gravel pits. The following is a list of rock-fragments, with their per centages, taken from a gravel pit at Gorton, near Manchester, and given by Mr. Hull.

Silurian grits	37 per cent.
Felspar porphyry	31 ,,
Carboniferous grits	14 ,,
Pophyritic conglomerate	0 ,,
Carboniferous Limestone	3 ,,
Ironstone	2 ,,

Taking the brick-earths, sands, and gravels in the neighbourhood of Norwich, there is nothing approaching to this. Flints are everywhere the rule, every other kind of rock being the exception. Occasionally may be found an oolitic, or liassic pebble, or boulder, and sometimes fragments of car-stone, from the lower green sand in the north of the country. At Bramerton, in the sands over-

lying the Crag, I have found two specimens of *Gryphæa incurva*, from the Lias. On the Yarmouth road, about two miles from Norwich, there lies a tolerably large boulder of Greenstone; and at Postwick grove there is another, composed of Trap. This general absence of northern rocks indicates that these superficial deposits are more or less of local origin, and have not, as in the case of the drift beds in the neighbourhood of Manchester, come from a distance. There is also an absence of that glaciation so frequently met with in the north.

Another fact is worth mentioning. In the bed of upper brick-earth near Magdalen Chapel, and about six feet from the surface, a thin seam of re-deposited Crag runs through the entire course of the bluff. It is about two inches in thickness, and I identified the following fragments of shells, which I and Mr. T. G. Bayfield found in it:—*Cyprina islandica*, *Mya*, *Cardium*, *Mactra*, and *Tellina*. The occurrence of this seam in what is usually called the "Boulder-clay," is another argument in favour of that bed having been formed in a comparatively quiet manner.

I cannot help connecting the general absence of glacial indications with the flatness of the county of Norfolk. It is now generally admitted that, during the glacial epoch, streams of glaciers were distributed from various centres, these centres being on the highest grounds. As might be expected, the drift beds in the neighbourhood of each high ground would be richest in the variety of their pebbles and boulders, whilst they would originate under conditions far more boisterous and varied than the beds of similar age in Norfolk. The drift beds of the latter county, therefore, have peculiarities which have originated chiefly in the absence of hills and high grounds. At the same time there occur evidences of a colder climate, although these are not on so broad a scale as those which commonly occur in the north of England.

The thanks of the Society were voted to Mr. Taylor for his paper.

Mr. Binney—Mr. Taylor seems to think that the shells found about here are of a much more northern character than any found about the district of which he writes. Now, in the till at Blackpool the shells are all shells to be found in the Irish sea, without any exception, so far as my knowledge extends. You find them with the striated pebbles, but they are all recent shells. Also some shells I saw at Tintwistle, although 700 or 800 feet above sea level, were all like those found in the Irish sea. Mr. Darbishire, F.G.S., found and described some at Macclesfield, and they were chiefly shells now found in our neighbouring seas, with a few of a Mediterranean character. I think, therefore, it is going too far to say that those referred to were of an artic character. With reference to what Mr. Taylor says of the upper and lower brick clays, with gravel between, I think you will find in some places in the vicinity of Manchester not only one, but five or six beds of clay, separated by gravels and sands. Anyone who looks into the neighbourhood of Manchester, Pendleton, Stony Knolls, or towards the Stockport Road, will find the good brick clay, or "till," as it is called; and above the sand of Kersal Moor is another bed of clay, with scored pebbles in it, but it will not make bricks like the lower bed, I think. Mr. Goodwin once stated to this Society that he had found as many as six beds; and I myself have found as many, parted by sand. The till is clearly divided differently at different places, the sands and gravels intercalating with it.

Mr. Dickinson—In cutting through a main sewer at Pendleton there have been passed through a large number of thin beds of clay, after the main bed had been left. Having particularly noticed the section, while the works were going on, I can quite agree with the general tendency of Mr. Binney's remarks. There

is one point in this paper which might not perhaps be generally noticed, but which I will notice, because it bears out some of my views on the formation of the deposits mentioned. I refer to the per centage of the Silurian rocks, which is found amongst the pebbles of the so-called drift of this locality, and the almost, if not entire absence of such pebbles in Mr. Taylor's locality, showing that the pebbles composing these drifts have an origin different from that attributed by many geologists.

Mr. Binney—I have examined some of these beds of drift on the east side of England,—in Nottinghamshire, parts of Lincolnshire, Yorkshire and Durham; and in Nottinghamshire, in the brick clay, or till, I have found undoubted Silurian rocks, with fossils in them.

Mr. Dickinson—I think we are on the eve of some great changes. At the recent meeting of the British Association, at Bath, Sir Charles Lyell, the president of the section, and a geologist who stands deservedly high in the science, withdrew, so far as he himself was concerned, the view that granite is of igneous origin. He also stated in his address that the view usually taken by geologists,—that the whole of the metamorphic rocks have been due to igneous origin,—requires re-consideration. These two points, coming as they do from such a man as Sir Charles Lyell, show what is working among the upper grades of geological students; and as local Societies and individuals generally take their cue from leading geologists, I have no doubt we are on the eve of a change in the views which are taken of geology generally. I have put my views before this Society aforetime; and one of the leading features was that very point of Sir Charles Lyell's,—that the metamorphic rocks are due to aqueous, and not to igneous, agency. I have been one of the small band who has believed this for years, and we have fought the matter energetically in the face of many disadvantages. I may say I am the only one in this Society who

has stood up for this. When Mr. Plant read his paper on the so-called igneous rocks of North Wales, I was the only one who stood up for their aqueous origin. Since then I have read a Paper upon that very point which Sir Charles Lyell has now sanctioned; and my views were so far repudiated in this Society as not to be allowed to find a place in their Transactions.

Mr. Binney—I was at Bath, but heard nothing from Sir Charles Lyell to sanction Mr. Dickinson's published views. I was present at the formation of this Society, and have been at a good many meetings since, and am able to say that there has always been here a desire to hear both sides. In the early days of geology there was a great contest between fire and water amongst the Wernerians and Plutonists. The one wanted to attribute everything to heat, and the other to water. The partizans for 60 years stoutly opposed one another on every point, but there were always two views held, and this is often the way by which the truth is ultimately brought out. At the very first meeting of this Society there were questions raised as to the igneous and aqueous origin of mineral veins, and good evidence was adduced as to some having their origin from fire and others from water. As far back as the time of Werner granites were attributed to aqueous origin. Sir Charles Lyell, however old he may grow, is one of those truth-seeking men who will always be young to learn; and whatever his preconceived views may have been, or however many books he may have written, he will, if necessary, admit that he has been wrong, when it can be clearly proved that he is so. But he did not discover that some granites were of aqueous origin; that is as old as Werner. The toadstones of Derbyshire were once attributed to hot lava; but that hypothesis has been altered a good deal. It has been shown that lava, although it comes out of volcanos, often flows into the sea, and, when mixed with ash and green earth, may have quite a sedimentary appearance. So, that which was said to be of volcanic origin, is in reality partly an aqueous

deposit. Geologists should always be ready to change their views in accordance with new and additional facts. Ours is a young science, yet greatly to be advanced by fresh knowledge; but I am certain that some of those men who have worked at it 40 to 50 years must know more about it than those who have not worked at it at all, and know little or nothing of the subject. The business of a Society like ours is to carefully investigate the geology of our district, and not to waste our time in speculative geology.

Mr. Plant said he had noticed in the Paper the great distinction made by the writer between the drift in the neighbourhood of Manchester and in Norfolk. In Norfolk the drift was characterized by abundance of flints and shells, and the presence of deep beds of clay and sand in connection with the glacier boulders. He (Mr. Plant) could not help remarking that he differed from Mr. Dickinson's version of what Sir Charles Lyell had said. Sir Charles had never made any researches in granites, but had taken his views from Professor Haughton and Professor Scott, of Dublin.

The following Paper was then read:—

ALLUVIAL DEPOSITS ON TRAVIS ISLE, COLLYHURST:

By John Plant, F.G.S.

As any observation on the geology of this district is always acceptable, and as the record of every fact, however trifling, may be useful hereafter, when the scattered and unconnected materials which this Society and others have abundantly accumulated, are gathered into one work, embracing all that can be said upon the geology of Manchester and its neighbourhood, I have thought

it desirable, therefore, to make a record of a deposit which lies in the valley of the small stream called the Irk, at the bottom of which, in a bed of muddy silt, there has lately been found a large quantity of branches, leaves, and fruit of the common hazel.

The deposit forms the site of Travis Isle, Collyhurst, filling up one of the largest bends in the valley of the river, at a point where it is particularly interesting, from its affording a good illustration of the erosive action of water, even in so small an affluent as is this little stream.

This section of the valley may be seen from Buckley's red sand delph on the east, crossing Travis Isle, and bounded on the west by the high banks of Cheetham Hill. The width of the valley, measured from the till clay on each side, is about 500 yards. The banks are very steep, and on the west display a section of Bunter sandstone, Permian marls, limestone, and red sand beds, which latter appear to form the floor of the valley at this point. The present level of the stream is about fifteen yards from the highest part of the banks.

In a few places, like Travis Isle, the bottom widens out, but to a very limited extent; in all other parts the flood waters sweep the narrow channel perfectly clear of deposits, and the exposed strata belonging to the Coal-measures, Permian and Triassic rocks, may be seen.

The alluvial deposit on Travis Isle has been partially excavated for the foundations of a new school house; and the builder, Mr. W. Timms, to whom I am entirely indebted for the measurement of the different layers of deposit, called my attention to the quantity

of hazel nuts which were found in the lowest bed. In examination, I found that the total depth of the deposit resting upon the Permian sand was about 13 feet, composed in this manner:—

Below the surface soil there lay a bed of silt, of a blackish brown colour, loose in texture from the abundance of comminuted fragments of vegetable matter mixed with it. This bed varied in thickness, but the deepest part exposed was five feet thick. There were few pebbles found in this bed.

Below the silt was found from five to six feet of fine sand and gravel, variable in thickness, interbedded in the way which is generally called false bedding. The gravel and sand resembled very much the present sand banks and scours which are to be found in most of the Lancashire rivers. With the exception of the trunk of a large tree, which was not disturbed, as it lay just beyond the line of the foundations, no extraneous matters were noticed in this part of the deposit.

At the base of this sand and gravel lay the bed in which the hazel nuts were found. It consisted of a sandy silted material, blackish from vegetable matter, and somewhat in layers. This bed was unevenly spread over the Permian sandstones, filling the deep holes worn by the water in the sandstone floor, and lying but thinly over the higher portions, in some parts not appearing at all, as though it had been swept away.

The quantity of remains of leaves, branches, and nuts, was very large. The leaves were very perishable, and not capable of preservation. Most of the branches were pretty sound, but in fragments, with the bark so perfect that the silvery spots, so characteristic of

the wild hazel (*Corylus avellena*), were very discernable when first taken from the sand. The nuts were perfectly sound, and although at first black and soft from the moisture retained in the silt, as soon as dried became light in colour, and scarcely to be distinguished from the fallen nuts which may be gathered in a hazel copse in the autumn season.

Sometimes intervening between the hazel nut bed and the red sandstone was a band of greyish marl, but I think this belongs to the Permian formation, for it is very much like the marls found on the east bank, and its occurrence in places only may be due to the erosion of the stream.

A vote of thanks was passed to Mr. Plant for his contribution.

Mr. Barr said the description given by Mr. Plant coincided with that be (Mr. Barr) could give of a similar discovery near Stockport, on the banks of the Mersey, while getting out the foundation of a new chimney. Twenty or 30 feet down into the red rock the excavators came upon a darkish coloured bed, and in patches up and down there were large masses of vegetable matter, chiefly leaves, matted together, and a large quantity of nuts, similar to those shewn by Mr. Plant. No doubt similar remains had been found in many parts of Lancashire in the river sands. The nuts and leaves found near Stockport were darker than those found at Collyhurst, probably because of the intermixture with oak leaves and bark.

Mr. Binney said he had seen nuts dug up in the alluvium at

Pendleton and other places. He had no doubt that some time the river Irk went over various parts of Travis Isle; it might have gone close to the Cheetham bank within 300 years of their time. There was at one of the points shewn on Mr. Plant's section a terrace of river gravel, shewing the former existence of a body of water very different from that now flowing in the Irk. There was not probably much antiquity attached to the nuts. The changes of a river bed were very varying and sudden, for every flood cut its banks away more or less, and brought a little silt and deposited it on the adjoining flooded land. These river gravels on a level with the present water courses were very modern things; the difficulty lay in accounting for the terraces 40 or 50 feet above the present water level. The nuts and branches at Collyhurst might easily have been formed 150 years ago, when the old Irk was spoken of as a beautiful trout stream, and when there may also have been plenty of hazel and beech trees.

Mr. Plant said he could not agree with Mr. Binney as to the age of the bed which had been deposited at Travis Isle. It must be remembered that there were 13 feet of equal and slow deposits. There could be no exact date as to the rate of deposits in shallow rivers; but it must have taken more than 200 or 300 years to have accumulated 13 feet of such layers as these at Collyhurst. The time was more likely to be 2,000 or 3,000 years since the valley began to be re-filled with these beds of sand, after the stream had been large enough to wear out the extensive area from bank to bank. The river was gradually decreasing in its volume of water, and only occupied one-sixth of the area it occupied when these nuts were deposited.

Mr. Binney said his explanation was the shifting of the water-course. These deposits went on regularly from year to year when there was no embankment, and were made with great rapidity.

He had no difficulty in accounting for a deposit of river sand and gravel 13 feet in thickness in fifty years.

Mr. Dickinson said these hazel nuts in the river deposits seemed to be very general. He had himself seen them in Cornwall, where stream tin was being worked, at an elevation below that of the present sea level.

Mr. Barr said that in the locality which he had mentioned, were the nuts were found, there were many evidences as to the shifting of the stream. The boundaries of the borough of Stockport were formerly along the river, but there had been such a change within 200 years that there were now several acres belonging to another township.

Mr. Plant said it was quite possible the water after a flood scooped out for itself a new channel, which it filled for a short time. But such a channel, like those in the hills, was only periodical, and did not affect the boundaries of the valley of the river; and it would be quite a mistake to suppose that by such an agency this 13 feet of quiet and systematic deposit at Travis Isle had been formed. The deposit there was spread over four or five acres, and no doubt it was evidence of a great lapse of time, during which originally a lake or large pond existed, unaffected by the river; around its banks grew plenty of hazel trees; and that the sand and mud of the beds were brought there by the river which existed now, but in greater volume.

Mr. Charles Hardwick said he remembered the digging of the

foundations of a bridge at Preston at a spot where the tide joined the river; and when the red rock was reached, remains of nuts, branches, and leaves, very much decayed, were found.

This closed the discussion, and a vote of thanks to the President concluded the proceedings.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 4.] Vol. V. Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday afternoon, January 31st, 1865.

Andrew Knowles, Esq., President, in the Chair.

Mr. G. C. Greenwell made an observation respecting a paper he had previously read. He said—I wish to make a remark or two with respect to the fissure in the limestone referred to in the paper I lately read before the Society on the Somersetshire coal-fields. I was in Somersetshire a fortnight ago, and visited the quarry I mentioned. It is near a place called Nunney, on the south declivity of the Mendip hills, and perhaps about three miles S.W. of Frome. The quarry is an old one, and has been considerably worked; but as the workmen approached the fissures, the limestone, from not being so good, was stopped working. Being exposed, the place where the fossils were found was quite easy to find. It does not appear to be a surface cavity, or anything like a wearing away near the surface, filled up by surface deposit, but it is like some fault, or break in the limestone, showing a complete cheek, which at one time must have been open. Mr. Moore, of Bath, told me that these fissures go down through the limestone, and that the fossils are found through the whole thick-

ness. Mr. Moore thinks they are lias, but from the pieces of stone I found, I should think it is much more like the upper green sand. I have also here some shells I got from the clay at Penarth, near Cardiff, about 50 feet above the level of the sea.

Mr. Binney—I saw this place where the fossils came from when at Bath last year, and it is difficult to say what these fossils are. Many of them appear to belong to the lower lias, and upper trias; and it has long been a subject of discussion as to where the trias ended and the lias began. It is the same with the permian and coal-measures on the east side of England. In Lincolnshire and Yorkshire I could never tell where the trias ended and the lias began. It is possible that between our English trias and lias beds a great amount of strata has been removed, and as to which there is now but little evidence left of its former occurrence.

Mr. Greenwell—There is a case in point now being enquired into as between permian and coal-measures. There is in the north of England what has been called the lower new red sandstone, which is from 15 to 20 yards in thickness, and immediately under the sand, which lies under the magnesian limestone. It is now found that this is simply the coal-measures themselves, discoloured from some cause or other, because, although there is this band of coloured strata lying below the sand, it is found they are conformable with and a part of the coal-measures.

Mr. Binney—I have heard of that hypothesis. Having seen a good many such sections, I make free to say that I don't believe a word of it. No one will believe that there is no lower red sandstone on the east side of England, but that such rock is only discoloured coal-measures. It may be very well to say there is no rock between the soft red sandstone at Collyhurst and the coal-measures, but a series of beds there are. Whether it is better to call them an unconformable upper coal-field, or lower permian, I cannot say. This remains to be settled.

The thanks of the Society were given to Mr. Greenwell for the specimens he handed in.

Mr. John Stewart, of Church, presented to the Society a beautiful specimen of carbonate of lime, taken from the lead mines in the Isle of Man. It was pronounced by all present to be an unusually fine specimen of crystallisation, although Mr. E. Hull and Mr. John Plant expressed provisional doubts whether it was carbonate of lime.

The thanks of the Society were awarded to Mr. Stewart.

Mr. Wild presented a singular specimen of a bent calamite, found in the Blenfire rock, near Oldham.

A vote of thanks was presented to Mr. Wild.

The following paper was then read :—

ADDITIONAL NOTES ON THE DRIFT DEPOSITS IN BURNLEY AND THE NEIGHBOURHOOD:

By T. T. Wilkinson, F.R.A.S., &c., &c.

In very early times the town of Burnley derived its name from its position on the south bank of the River Brun. The alluvial "flat-meadow" on which the old town and church are situated, was in fact the "ley," but this characteristic designation is no longer applicable. The southern branch of the River Calder finds its way through Townley Holm, another alluvial deposit of much greater

area, and now unites with the Brun at a point which will soon be not very far from the centre of the town. Whether these two rivers ever had a junction near to a low-lying portion of the town, not improperly termed Wapping, may be open to dispute; but the river gravel lately thrown up from some excavations in Saint James Street, lends its aid towards a proof that the Calder has indulged in some strange meanderings in former ages.

It is not at all improbable that the site of the lower portions of Burnley may formerly have been a lake, or at least an extensive morass, and that the area has been drained by the united waters of the two rivers having worn away the barrier near to Stoney Holm; be this as it may, the town now stretches along the four banks of the Calder and the Brun, and stands almost in the centre of one of the richest portions of the coal-field of East Lancashire. The course of the Calder contains no natural sections of any importance; but that of the Brun runs along a fault which exposes the *Low Bottom*, the *Cannel*, and the *Thin Beds* of the Burnley coal-field, in the fine natural section at Heysandford.

The rapid increase of the town of Burnley has consequently led to many excavations,—some for building purposes, and others for gas and water storage. During these excavations we have had an opportunity of obtaining some information as to the nature of the drift deposits in the town and neighbourhood; and I now propose to add a few short notes to those which are printed in p. p. 108, 113, Vol. IV, of the Transactions of this Society.

In a section exposed for a short time at Healey House, near Burnley, some singular evidence was afforded of the action of running water at an elevation of at least 100 feet above the present bed of the Calder. The current would seem to have passed over the edge of a fault which throws out the *Bing Bed* of coal at this

place. The strike of the fault is from west to east, and the deposits on the south side presented the following appearance:—

a.—Coarse yellow gravel, almost horizontal.

b.—Blocks of stone, apparently the *debris* caused by the displacement of the sandstone rocks below.

c.—Alternate layers of sand and coal, the *debris* of other strata, and exhibiting many marks of the action of running water. These layers are unconformable to the gravel in (*a*).

d.—Dense dark-colored clay, mixed with boulders and pebbles; this drift-clay (*d*) lies unconformably on (*c*).

The particulars of this section appear to indicate that this portion of the county was under water, and probably formed part of the sea shore before the deposition of the boulder drift. Red sandstone boulders of the millstone grit formation have been found in abundance during the excavation of a deep sewer in Huffling Hall Lane, near Burnley Wood. Limestone, gannister, and other pebbles were numerous; and so also were the remains of *Lepidodendron*, *Calamites*, and *Ferns*. These were all enclosed in the boulder clay, and had retained their coatings of pure coal almost uninjured. In Bank House Street, Burnley, large portions of *Sigillaria* occur, as boulders, intermingled with limestone and other debris. A very fine specimen of *Lepidodendron Sternbergii* was recently procured from the quarry near to the Angel Inn. It consisted of two stems, probably *twin* trees, firmly compressed together. Good specimens of *Calamites approximatus*, with the points quite perfect, are also abundant in the shales and sandstones, which just underlie the drift in this quarry. During the past year the Corporation of Burnley decided upon making a new gas-tank, of large dimensions, at their works near Stoney Holm, and hence had two trial borings made, in order to ascertain what kind of strata would have to be passed through by the excavators. The first boring was made about 70 feet from the present bed of the river Calder, and was reported by the workmen to the gas manager as follows:—

	Feet.	Inches.
Surface mould, gravel, &c.	1	8
Blue clay, very good, almost without stones	17	10
Soft laminated sand, and clay in layers—quicksand	12	0
Blue clay, full of stones	14	3
Strong shale, or rag, not pierced through	6	9
Total	52	6

The second boring was about the same distance from the river, and the workmen reported the strata as below:—

	Feet.	Inches.
Surface mould	0	9
Gray marly clay	2	0
Gravel, sand, stones, and wood	4	10
Blue boulder clay	4	5
Hard blue metal shale	8	6
Rock, black grit	0	8
Hard shale, rag	3	3
Rock, not pierced through	0	5
Total	24	10

This was the site adopted for the tank, in consequence of the apparent absence of the quicksand; but on the excavation being actually made, the deposits were found to differ very considerably from those indicated by the borings. This appears to me to furnish a caution against placing too much reliance upon the indications of small perforations through the drift deposits. Isolated stones are liable to be mistaken for real seams of rock; and in this neighbourhood the coal shales might be suspected to exist many feet above their actual position. The real deposits in four different places were found to be as follows:—

FIRST SECTION.

	Feet.	Inches.
River gravel, at least twelve feet above the present bed of the Calder	6	0
Clay and sand, in alternate layers	6	0
Blue boulder clay, very dense, not pierced through	8	0
Total	20	0

SECOND SECTION.

	Feet.	Inches.
Surface mould	0	6
River gravel	7	0
Clay and sand, in layers	2	6
Blue boulder clay, not pierced through	11	0
Total	21	0

THIRD SECTION.

	Feet.	Inches.
Surface mould	0	6
Yellow clay	4	0
River gravel	4	6
Blue boulder clay	14	0
Strong shale, rag, not pierced through	2	0
Total	25	0

FOURTH SECTION.

	Feet.	Inches.
Surface mould	0	6
Yellow clay	1	6
River gravel	5	6
Blue boulder clay	18	0
Strong shale, rag, not pierced through	2	0
Total	27	6

In the third section two oak trees were met with, each lying prostrate beneath the yellow clay. The first tree was about 39 inches in diameter, and the central portion of the trunk was still very sound. The second specimen was about 45 inches in circumference, and much decayed. During the progress of the excavations *Sigillaria*, *Stigmaria*, *Calamites*, *Lepidodendra*, *Lepidostrobi*, *Sphenopteris*, *Pecopteris*, &c. &c. were met with in abundance. One or two of the trunks of *Sigillaria* were over six feet in circumference. The *Anthracosia robusta*, &c. were plentiful amongst the lower portions of the boulder clay; and so also were small boulders of black shale, much water-worn, but full of *Lingula squamiformis*. Many of the sandstone boulders were much scratched and striated; and the same appearances were presented by the dark limestone boulders, but in a much more marked degree. Most of these must have been carried by glacial or iceberg agency from a great distance. One of the best of these has been preserved at the

Burnley Grammar School; and the groovings on its surface are as regular and perfect as if they had been scooped out by the hand of man. A cylindrical mass of hardened clay, or shale, has also been preserved in the same place, which, when broken transversely, exhibits a mass of semi-carbonised matter in the wildest confusion. It appears as if it had been rolled into this shape by the action of water, just as masses of red marl are now being rounded by the action of the waves on the shores at Blackpool.

Several large boulders of "rough rock" were found near the bottom of the excavation, which were remarkable for their deep green colour. The encrinital limestone boulders were in general much water-worn, but they contained *Productæ* and *Spiriferæ* in abundance. Some of the grit boulders were very hard, and were chequered with deposits of carbonate of lime, or silica, in veins. Occasionally a mass of silica formed a nucleus, from which the veins radiated, as from a centre, in every direction. An ironstone nodule was met with at a depth of 14 feet in the boulder clay. It is exactly the shape of the upper portion of the thigh bone of some animal, and has even a cavity for the marrow at the fractured end. It may also be worthy of notice, that one of the grit boulders, which was at first mistaken by the workmen for limestone, was buried upwards of three feet in the solid shale. May not the boulder have been deposited there at a time when the now hard shale was in a state of fine mud at the bottom of some ancient sea? The nature of the drift deposits have also been recently tested in several places at a short distance from Burnley. At Swindon several trial borings have been made with a view to the enlargement of the Old Compensation Reservoir.

FIRST BORING.

In the bottom of New Compensation Reservoir.

	Feet.	Inches.
Blue loamy clay	4	6
Yellow clay	3	6
Blue clay, compact and dry	7	0
Total	15	0

SECOND BORING.

	Feet.	Inches.
Yellow clay	4	0
Blue clay, rather sandy	6	0
Blue clay, compact and dry	9	0
Total	19	0

THIRD BORING.

	Feet.	Inches.
Rough gravel and boulders	8	0
Blue clay, somewhat sandy	6	9
Blue clay, dry and compact	5	3
Total	20	0

FOURTH BORING.

	Feet.	Inches.
Yellow clay	1	6
Blue clay, sandy	4	0
Blue hard clay	17	6
Total	23	0

FIFTH BORING.

	Feet.	Inches.
Yellow clay	6	0
Blue clay, soft	3	6
Blue clay, hard and compact	10	6
Total	20	0

One or two of the preceding sections may have been a little modified by landslips, inasmuch as the valley in which the reservoirs are situated is rather narrow; but the *triple* character of the drift may be inferred from several of them, even in their modified condition. This characteristic is still further exemplified by the following sections, which have been actually verified at Lee Green Reservoir, near Extwistle Hall.

FIRST BORING.

	Feet.	Inches.
Yellow clay	3	0
Blue clay	4	0
Sand	7	0
Gravel	8	0
Blue clay	5	0
Rock	1	0
Total	28	0

SECOND BORING.

	Feet.	Inches.
Yellow clay	3	0
Blue clay	5	6
Sand	2	6
Hard blue clay, with sandstone boulders	9	0
Rock, or boulder stone	3	0
Total	23	0

THIRD BORING.

	Feet.	Inches.
Gravel	16	0
Sand	11	0
Blue clay	6	0
Total	33	0

Several other sections were taken, but as they did not pierce through the drift they need not be given. In excavating for the puddle trench it was found that the loamy, laminated sand and clay, penetrated much further into the hill on the Extwistle side than was expected. It did not appear to hold much water in the direction in which it was traced, but the engineer was obliged to take extra precautions in order to get rid of so treacherous a material. As a concluding example, I may give the following section of the drift deposits of this district, as proved at Dean quarry, near Simonstone, Padiham:—

	Feet.	Inches.
Vegetable mould	1	0
Yellow clay, mixed with sand	4	6
Dense blue clay, with a few gannister and sandstone boulders	9	0
Laminated sand and clay	Variable.	
Very dense blue clay, full of rounded and striated limestone pebbles and boulders	15	0
Sandstone rock, thick flags, &c.	75	0
Coal-measure shales	Not known.	

The sand between the clays varies in thickness from 2 inches to nearly a foot. It holds a considerable quantity of water, and furnishes a never-failing spring at its outcrop in the meadow above the quarry. In one portion of the cutting all the limestone and other pebbles lay inclined towards the south-west. This appears to

prove that the current under which these deposits were formed tended from N.E. towards S.W., or from the present German ocean towards the Irish sea.

Throughout the whole of these trial-borings and excavations nothing has been found in the drift deposits which would indicate the existence of man. A curiously and sharply cut stone, found in a cutting near Bank House Street, at one time excited my suspicions, but on a closer examination the fractures presented no appearances which could not have been produced by natural causes. Probably the rigours of the glacial period were too intense for his existence in these latitudes, and hence the traces by which his handiwork may be recognised must continue to be sought in other regions, and amongst other deposits, where he was surrounded by more congenial conditions.

The thanks of the Society were given to Mr. Wilkinson.

Mr. Binney—In one part of his paper Mr. Wilkinson asks whether the coal shale underneath might not have been in a soft and muddy state when some of those pebbles were thrust into it. Doubtless the pebbles got into the shale ages upon ages after its formation. This may have arisen from denudation, and by the shale having been softened by a good deal of water upon the bed. Whenever you look at the surface of a rock, with drift deposits over it, some strange scoopings out will be seen. I have noticed some very large ones worked out in a circle, and conical at the bottom. There are examples at Collyhurst and Ardwick. Some people call them pot-holes, but they are different of course from the pot-holes or casts of *Sigillaria*, so commonly found in coal-measures. In Ardwick, a large stone, well polished, rounded and pointed at the end, was found three feet in a sand rock (trias).

Several gentlemen mentioned that they had seen specimens of these stones.

The President—And if the material forming the pebble was heavier and harder than the strata, it would have the tendency to sink through the soft material.

Mr. Binney—In forming our conclusions we should remember that these old rocks, with the drift deposit upon them, have been subject to many agencies. The action of glaciers and ice alone, or in connection with water, is now occupying the attention of all geologists, and there is a great deal to be said on either side. This paper is all the more valuable because it gives us a lot of facts, without speculating upon hypotheses. As to how these holes have been made, the more people look at them, and carefully consider them, the less they will be likely to pronounce a dogmatic opinion as to their origin.

Mr. E. Hull—In listening to the paper, it seemed to me there was some sort of similarity between the drift deposits in Burnley and those of this part of the country. I took the liberty of dividing them into three subdivisions in place of the two which Mr. Binney had previously made. There seems to be, with considerable variation it is true, an upper sort of boulder clay, a middle sand, and a lower blue boulder clay in this and the Burnley system. And the more I see of these separate observations over different parts of Lancashire, the more am I confirmed that these three divisions can be maintained. With regard to what Mr. Wilkinson says about the remains of human workmanship in these deposits, it is to be recollected that no implements or works of art have been discovered in these drift deposits—none that are referable to the drift period. The beds of gravel in which the flint implements have been found, both in this country and on the continent, are referable to a later period.

Mr. Binney—The drift deposits in the neighbourhood of Burnley, if, as everybody admits, the land has been gradually rising, would be in a very different position to the drift deposits here, because the land there would be considerably out of the action of the water, while the land here would be low in it. You will have different drifts at different elevations. In the sand at Kersal Moor there is a lot of blue clay, with scored pebbles in it, and in many other places you may find three or four beds of clay with pebbles, parted by beds of sand. There is a case at Blackpool where you see beds of sand and gravel with clay above and below. But a little further on the sand and gravel disappear, and there is only one bed; and in some places you may have these four or five beds of clay, with the sand and gravel all thinning out and running together into one bed of clay. If anyone begins to make bricks of it he will find the so-called top boulder clay about Manchester a very different thing to the great till deposit at Cheetham.

Mr. Hull—The upper till you refer to makes capital bricks at Oldham; and the reason the clay does not make good bricks at Cheetham Hill is because it is of no thickness. I have traced the upper till, as well as the lower intermediate sand, step by step from Manchester to Oldham, and southwards to Cheshire, and in the direction of Wigan, and although I grant that the sand sometimes runs out — possibly it has been denuded away—it does come in other places in force, and preserves a very definite position with regard to the two tills.

Mr. Binney said a very good section of the till might now be seen in Waterloo Road, where the clay with pebbles was absent, and its place occupied by stratified sand.

The following paper was then read:—

ON THE

DISCOVERY OF PARADOXIDES DAVIDIS AT TYDDYNGWLADIS, NEAR DOLGELLY, NORTH WALES:

By John Plant, F.G.S.

The Trilobite Paradoxides, perhaps known to Linnæus in 1753, was first described by Brongniart in 1822, who placed it in his first division of Trilobites, viz. :—those incapable of rolling themselves into a ball; the division includes several genera, all of ancient Geological date. The Trilobites, of which Paradoxides is a prominent species, are distinguished by the structure of the lateral lobes of the body, which preserve the same breadth, without diminishing towards the upper end and external side towards the margin; in the smallness of their elongated and depressed eyes; and in other characters, which present differences of generic and specific value. *

Paradoxides has been unknown to belong to British strata till within a very recent period—if we except the solitary figure in Murchison's "Siluria," named *P. Forchhammeri*, which was found in North Wales some years ago, by Mr. Selwyn, in what locality has never been known; but the species are common enough in the beds of Lower Silurians, forming the Primordial Zone of Barrande, in Bohemia, and in the Taconic system in North America.

In 1862, Mr. Salter, the able Palæontologist, when on a visit in Pembrokeshire, South Wales, examined the Cambrian and Lower Silurians, in the vicinity of St. Davids, and had the good fortune to find, in a thick mass of black slates and shales, fragments of Paradoxides; and in 1863, with the assistance of several local geologists, and Professor Griffiths, of Liverpool, the locality was diligently searched, and the result was the discovery of many fine specimens of a new and gigantic species of Trilobite, which Mr. Slater has named Paradoxides Davidis, together with other new forms, figures and descriptions of which have appeared in the Geological Journal.†

* Burmeister Organization of Trilobites.—p. 55, tab. 1; fig. 5.

† Quart. Journ. Geol. Soc., 1863.—p. 274; 1864,—p. 233.

In May, 1864, I received a communication from my former pupil in geology, Mr. Ezekiel Williamson, then employed in the gold mines at Cwmheisian, Merionethshire, enclosing a sketch of a fossil which had been accidentally found by Mr. T. A. Readwin, F.G.S., a member of the Manchester Geological Society, near the locality of the Tyddyngwladis Mine, I recognised in the sketch a portion of Paradoxides, and advised Mr. Williamson to make a careful search in the neighbouring slates for the bed from which the specimen had been probably washed out. In July Mr. Williamson himself found another specimen, lying loose on the hill, these two specimens were seen soon after by Professor Rupert Jones, Professor Ansted, and Mr. Salter, and by them recognised as undoubted Paradoxides.

From these discoveries it was evident that the fossils were indigenous to the slates near the mines, and Mr. Williamson commenced a very careful search in the exposed slates, just over the silver lead mine at Tyddyngwladis, and soon after found several fragments of spines, body rings, cephalic shields, and long spines enclosing the tail lobes; encouraged by his success, he worked indefatigably for several months, and procured a considerable number of specimens, many fragmentary, but a few nearly perfect, of the giant Paradoxides.

The publication of Mr. Salter's Memoir in the Geological Journal renders it unnecessary to enter into a minute description of these specimens, as it is acknowledged by Mr. Salter that many of them are identical in specific character with those figured by him from St. Davids; but there are many fragments in the specimens found at Tyddyngwladis which bear no resemblance to the figures, and these upon further examination may prove to be new or undescribed Trilobites. All the specimens found at Tyddyngwladis are much broken by the numerous jointings which have dislocated the slates into rude cubes from 2 to 12 inches in size.

The geology shown in the Section has been prepared by careful measurements through the adit of the mine, and by the outcrops on the hill. It differs considerably in its detail from the section, No. 37 of the Geological Survey, although the line of each section is nearly coincident; but Mr. Williamson has the chance of being the most correct, from the advantages afforded to him by his constant labour at the mine for more than two years; every yard of the strata in the mine and on the hill has been measured and examined with great care many times over.

The strata are faulted in every direction, and partially obscured by the occurrence of interbedded and eruptive traps, but the Tyddyngwladis strata bear a close analogy to the Cambrians and Silurians, as exhibited in the section of St. Davids, by Mr. Salter, in the Geological Journal.

The general Section is about eleven miles in extent, commencing on the west at Llanbedr, and extending to the hill on the east called Moel Hafod Owen. To the westward are thick masses of coarse red and purple grits, forming the Cambrian base; these roll away towards the coast in a succession of mountainous ridges, the slopes of which are strongly marked by glacial action, the valleys blocked up with morains, worn boulders, *roches moutonee*, perched blocks, and other evidences of great glaciers.

Resting upon these Cambrian grits, near Tyddyngwladis, are beds of slate, without cleavage, more or less striped with cinder and ash deposits, with interbedded felspathic traps, the total thickness being 1,136 feet. In the valley of the Mawddach, a deep fault occurring, renders the true succession of the immediate strata doubtful, but on the rising ground to the east the beds are well displayed in the clear outcrops, and were measured at the base in the adit of the mine. These strata form a series of hard grey striped slates and waxy grits, at present unfossiliferous, with irregular bands of felspathic traps partly interbedded, and partly intrusive.

Upon these, forming the commencement of the Lower Lingula flag series, rests a great thickness of altered felspathic sandstones, with a bed of quartzite. This series is locally named the Cwmheisian flags.

The strata, counting from the first bed of slate over the Cambrian grits, as far as the base of these Cwmheisian flags, form a distinct Primordial zone, containing fossils, such as *Theca*, *Paradoxides*, *Anopolenus*, of older type than those which are found in the strata lying above the Cwmheisian flags, viz.: *Lingula*, *Olenus*, The order and thickness of the beds displayed in the section west of the valley are as follow:—

Thick beds of coarse red and purple grits	Cambrian
Hard Slate, filled with ash and cinder deposit	119 feet
Felspathic Trap	40 ,,
Hard Slates, with fewer ash and cinder lines	75 ,,
Felspathic Trap	165 ,,
Slates finely bedded, without ash (*Anopolenus* and *Theca*)	217 ,,
Felspathic Trap	198 ,,
Slate of a softer nature—dark, grey, black (*Paradoxides* in abundance, and a few *Theca*)	190 ,,
Felspathic Trap	132 ,,
Total thickness	1,136 feet.

There can be no doubt that further discoveries will be made in other localities in North Wales, now that the relation of these strata has been made known, and that along the line of super-position of these lower Silurians, or upper Cambrians (whichever they are claimed to belong to) over the true Cambrian purple grits, the slates will be found to be rich in fossils of a primordial type; but until there is a taste for geology, and a love of observing and collecting diffused amongst the workmen at the mines, such discoveries will be few and of little value.

In this same mining district of Tyddyngwladis the adit of the mine and shafts had been driven through the slate abounding in Paradoxides for years, and tons of waste tumbled into the river, without the discovery of a single fragment of this interesting fossil

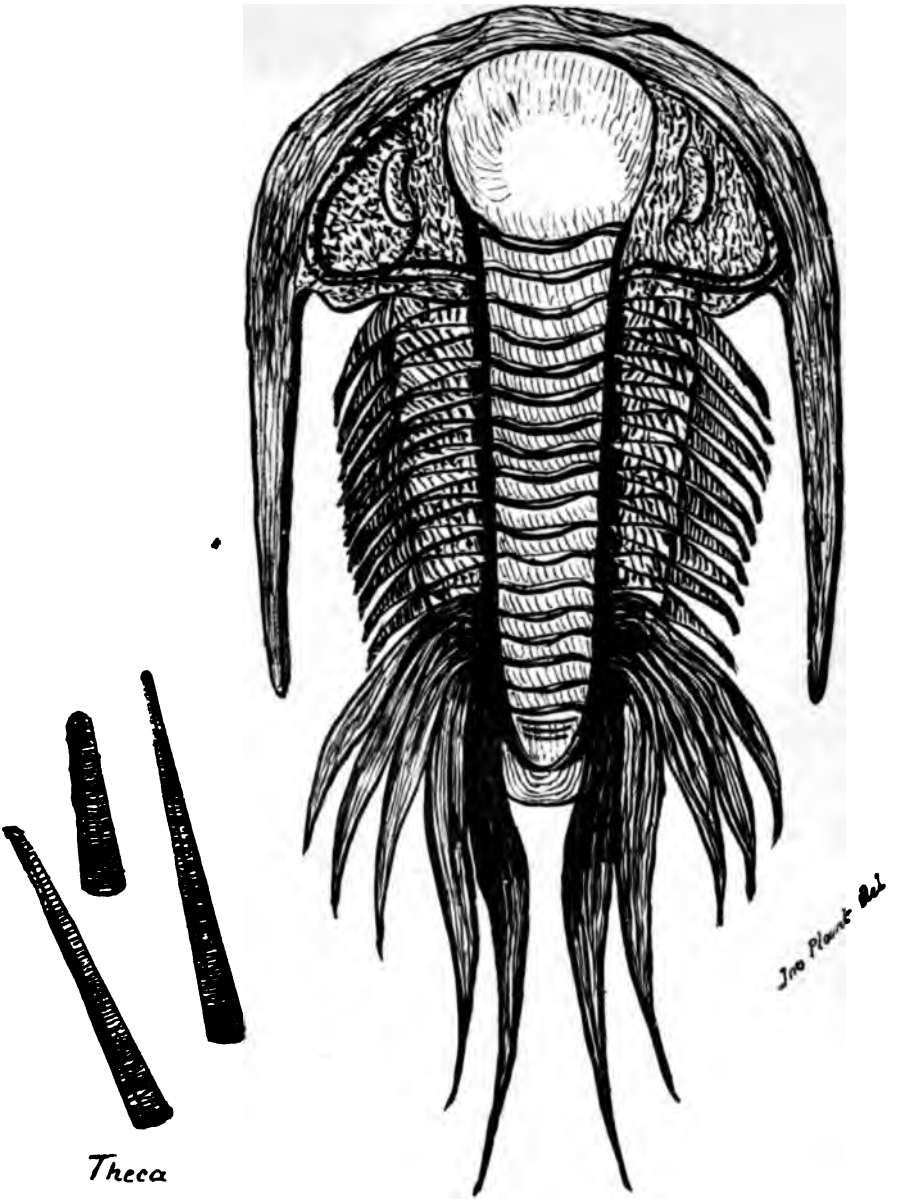
by the ignorant agents and miners; but through the intelligence of Mr. Williamson, a young miner, who had acquired a knowledge of geology at the Salford Working Man's College, this valuable discovery in Palæontology has been given to science, and the locality will become a favorite one to the field geologist.

The Sections accompanying this paper show the general relations of the formations from the coast at Llanbedr to Moel Hafod Owen, about eleven miles, and in No. 2 the hill at Tyddyngwladis, with the position of the slates bearing fossils. No. 3 is a sketch of one of the specimens of Paradoxides, and the mollusc Theca.

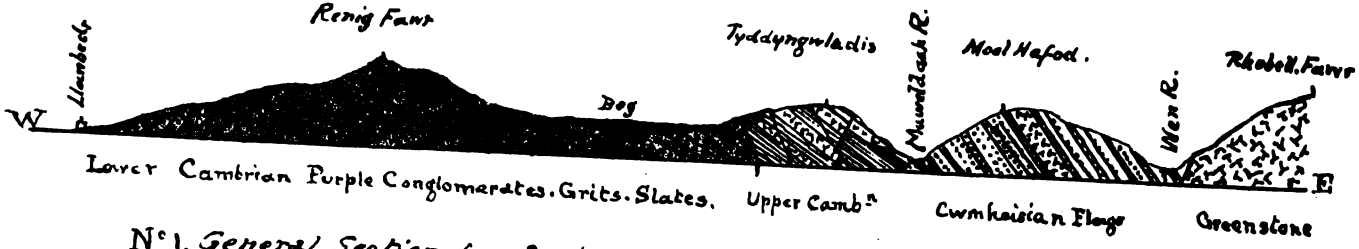
The thanks of the Society were voted to Mr. Plant.

Mr. Eskriggo said the Paper had been very interesting to him, because he had lately visited the locality in St. Davids, where the Paradoxides was first found, and the position of the strata relative to the Cambrian were exactly the same in the two localities.

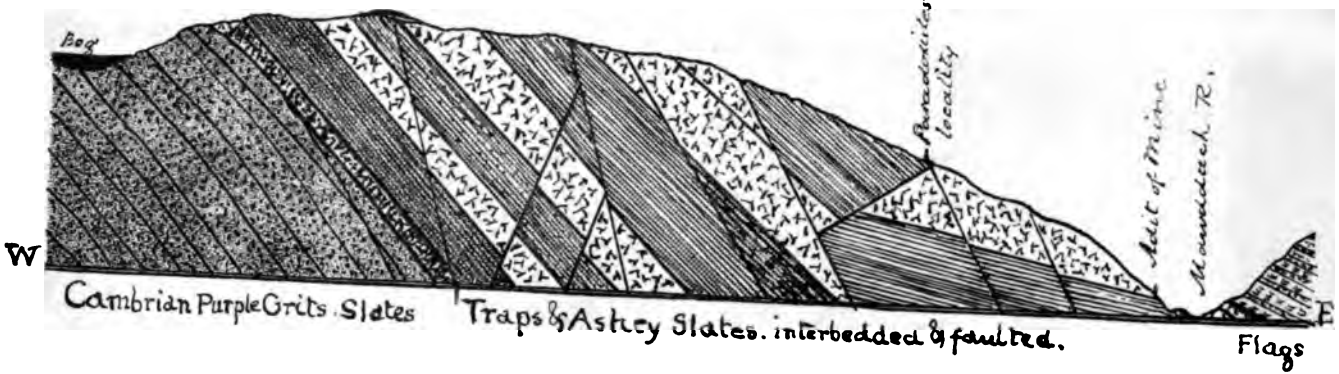
After a slight conversation upon the prevalence of imposition in offering fossils by navvies, a vote of thanks to the President closed the proceedings.



PARADOXIDES. Restored form.
Tyddyngwladis.



N°1. General Section from East to West for Nine Miles.



N°2. Section of Strata at Tyddyngwladis Mine.

Jno Plant del.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 5.] VOL. V. [Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter-street, on Tuesday afternoon, Feb. 28th, 1865.

ANDREW KNOWLES, ESQ., President, in the Chair.

Mr. Devis, Curator of the Queen's Park Museum, was elected an Honorary Member of the Society; and it was announced that Mr. Whipp, of Bowdon; Mr. E. Ashworth, of Brandwood Lane, Waterfoot; Mr. James Newall, of Bury; and Mr. James Grimshaw, of Kersley Mount, Radcliffe, were elected Ordinary Members.

Mr. J. E. Forbes, Honorary Secretary, announced that there had been presented to the Society a specimen of the *Trilobite* (*Paradoxides*), referred to by Mr. Plant at the last meeting, and the following publications:—

The Annual Report of the Geological Survey of India, and of the Museum of Geology, Calcutta; two vols. of the Memoirs of the Geological Survey of India; Sitzungs Berichte der Naturwissenschaftlichen, Gesellschaft Isis zu Dresden Jahrgang, 1863; Die

Philosophie un Cyclus der Naturwissenschaften, Vorwort zur Eröffnung des Naturwissenschaftlichen Cyclus in Dresden, von Dr. Adolph Dreschler; the Annual Report of the Leeds Philosophical and Literary Society; and the Report of the Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire for 1863.

The thanks of the Society were given to the donors.

The President stated that the Society had invited the members of the North of England Institute of Mining Engineers to visit Lancashire, and that the invitation had been accepted.

Manufacture of Fossils.

The following remarks relative to some spurious drift shells made at Macclesfield were read by Mr. Plant:—

I wish to call the attention of the Society to a serious fraud, which has been going on for some time, by the workmen at the excavations for forming the new cemetery grounds at Macclesfield. It seems that when these excavations first commenced in the gravels which belong to the drift in that locality, a number of fragments of shells, and occasionally a few nearly perfect ones, were found by the workmen; and that they fell into the hands of gentlemen who take an interest in the local geology. The workmen were stimulated to take care of everything unusual which they found in the excavations, by the pecuniary rewards which they received for their finds; and there can be no doubt that some shells and abundance of fragments were really taken out of the gravel. The knowledge of these discoveries came before the scientific world in a very short time, and

many visitors found their way to the excavations, ready to purchase whatever the men had to dispose of. The men appear to be gifted with the usual faculty of turning an opportunity to the best account to themselves, and as the supply of the genuine article was a very limited one, it was found that a spurious one could be readily manufactured, better in some respects than the genuine, and that all visitors could be supplied with better shells, in greater variety, than at first. The men are doubtless too ignorant to appreciate the effect which would follow, when their spurious shells were accepted by geologists as genuine species derived from the drift deposits; to them it was simply shells which were asked for, and they offered shells for sale. But the society will well understand the value of any deductions made by a man of science from elements which may be proved to be based upon fraud. The mode in which these shells are made available for sale is by fire or acids. The men procure the shells from Liverpool, Southport, and Ireland, if they have friends there—they even rob the rockeries and garden plots which have shell-work about them, and, having no knowledge of species, they have lately been operating upon West Indian and African shells, as you see in the specimens now before you. These shells are fired for a short time, or treated with acid, to deprive them of their epidermis, and bring out a thin coating of burnt lime; and to give them a gravelly tinge they are well shaken in a handful of gravel, and are then ready for sale. The practice has been in operation for some time, and it is a boast of the excavators that they have been very successful. I think it is a duty in every true geologist to do his utmost in exposing such fraudulent proceedings; and as a knowledge of these matters has come to me, I thought it proper to mention it in a meeting of the society. In addition to these genuine and spurious drift shells which are before you, I have a sample of a still more audacious attempt at fossil manufacturing from the same place: it is a piece of Ketton oolite limestone—a fragment from a stoneyard—in which is a specimen of a recent *Tellina*, with all its colouring retained, most ingeniously buried and cemented in the stone. It is cleverly done, and, but for the incon-

gruity of seeing such a species in oolite, would at first sight be very apt to deceive even a geologist.

In the course of a conversation Mr. Plant said that the workmen who were concerned in these frauds made no secret of what they had done.

The President said the Society, and geologists generally, were under many obligations to Mr. Plant for the exposure he had made. Such impositions, no doubt, often occurred, and the sooner they were discovered the better.

The following paper was then read:—

ON CERTAIN APPEARANCES OF GLACIAL ACTION ON ROCK SURFACE NEAR CLITHEROE; AND INCIDENTALLY A BRIEF DESCRIPTION OF THE CHIEF GEOLOGICAL FEATURES OF THAT LOCALITY:

By Mr. John Aitken.

The river Ribble is one of the numerous streams which take their rise in that elevated portion of the Penine chain, having for its culminating points Whernside, Ingleborough, and Pen-y-ghent. This high range of hills, not inappropriately termed the "back bone of England," is a region from whence descend several rivers, falling on the one hand into the German ocean, and on the other into the Irish Sea. Amongst the former may be mentioned the Air, Wharf, Nid, and Ure; and amongst the latter, the Ribble, Greta, and Lune.

The general direction taken by the Ribble, from its source down nearly to Cold Coniston, is that of almost due south; from thence

it runs south-west, and, after having its waters augmented near Whalley, by the addition of two streams, the Hodder and Calder, it finally falls into the Irish Sea at Lytham. Throughout the principal parts of its course it passes over the carboniferous limestone—this formation prevailing nearly to Ribchester, and from thence, through narrow belts of millstone grit, new red sandstone, and tertiary formations respectively.

A spectator standing upon the rugged elevation, surmounted by the ruins of Clitheroe Castle, formerly a stronghold of the powerful De Lacy family, and dating from the reign of Henry I, on looking north-east, would find a range of hills forming the eastern boundary of the valley, and terminating to the south in the bold and elevated block of land, rising in Pendle Hill to an elevation of 1,830 feet above the level of the sea, which presents in the landscape of this northern portion of Lancashire so striking and prominent an object. Between the river Ribble and Pendle Hill, he would further find several minor ridges of elevation, running mainly in the line of the valley; upon the southerly point of one of these is situated the Castle, which I have selected as the point of observation, and the rock, on which the superstructure is raised, forms the boundary of the mountain limestone at this point. From these ridges or lesser hills is obtained the principal portion of the stone so extensively quarried in this locality for macadamizing and building purposes, and burning into lime.

The beds of limestone forming these elevations dip at an angle of from 20 to 50 degrees towards the east, and lose themselves under Pendle Hill, being succeeded in ascending order by the limestone shales, which occur here of a thickness estimated at upwards of 500 feet, and consist of a series of beds of black laminated shales, cherts, and thin bands of lime and gritstones; the whole surmounted by a capping of lower millstone grit, more than 200 feet thick.

Perhaps the best and most interesting section of this formation

to be found in Lancashire, is exhibited in Mearely Clough, on the south-western face of the hill, where the various strata composing this formation are well exposed, and can be examined with facility; and as it yields numerous characteristic fossils, it is rendered additionally interesting not only to the geologist, but also to the student in the kindred science of palæontology. The excessive angle of dip shown by the strata of this locality is maintained, if not increased, towards the east, until the coal-measures on Padiham heights are reached; from which point the angle gradually diminishes, till on reaching the coal-basin which underlies the town of Burnley, the strata have assumed the horizontal position, while still further to the east the direction of dip is found to be reversed, and inclines to the common centre.

On looking to the west, the eye of the spectator would rest upon Longridge Fell, a long swell of elevated moorland, forming the boundary of the valley in that direction, and near to the summit of which, the millstone grit would be seen to protrude in several places. On looking along the valley to the south, in the direction of Blackburn, his eye would first rest upon the limestone shales extending to beyond Whalley, where they dip under the high rolling ground, which is capped by members of the millstone grit series, and which separates the latter-named place from Blackburn, and were he able to overlook this elevated ground, he would find the coal-measures succeeding the millstone grit a short distance beyond that important town.

The particular contour of the district of Ribblesdale is described by Professor Phillips in his "Geology of Yorkshire" as resulting from the disruption which took place in consequence of the elevation of the great Penine chain, and the ranges of hills, and lines of valleys as being indications of the direction of minor disturbances or offshoots of the great Craven fault. He says, "The country south-west of the Craven fault, which ranges from Kirby Lonsdale, by Settle, towards Pateley Bridge, has its own system of disturbances

chiefly in the direction of N.E. and S.W. Anticlinal lines of convulsion in this direction traverse the country from Lothersdale, by Pendle Hill, Whalley, and Blackburn; some pass through the district of Whitewell and the trough of Bolland, and others, through the centre of the Craven depression. The most striking features of this part of Craven and the adjacent tracts, depend on the N.E. axis of movement, as the grit summits of Longridge, the limestone valley of Bolland, Pendle Hill, Padiham heights, the Burnley coalfield, the limestone valleys of Lothersdale, Skipton, and Craco. It is remarkable that in the northern part of their range, these dislocations change their direction, and turn E. and W. so as to approximate to the line of the great Craven fault."

During a visit I recently made to Clitheroe, in company with Mr. Parker, of this Museum, (a gentleman, let me say in passing, who, by many years of labour and close observation, has made himself thoroughly acquainted with the geology, and no less so with the palæontology of this interesting locality, and whom I have always found ready to place at the disposal of the enquirer the knowledge he has acquired), and while at Salt Hill quarry, now being worked by Messrs. James Briggs & Sons, in one of the elevations before referred to, situated about one mile north of Clitheroe, my attention was drawn to the unusual appearance presented by the surface of the rock, from which the thin covering of soil and gravel had been recently removed, preparatory to its being quarried. On examination we found a channel running along the crest of the hill in the direction of N.N.W. and S.S.E. This was uncovered for a distance of about 15 yards, and presented every appearance of being continued further towards the north, the transverse section of the blocked up channel being well exposed, and easily traced at the point where the earth had not been removed from its basin. Mr. Parker informs me that he observed a similar phenomenon, some years ago, at the distance of about 200 yards in a southerly direction from this place, being evidently a continuation of the same. The channel was from eight to ten yards wide, and, owing to the

rapid dip of the rock, was considerably lower on the eastern than on the western side, its depth at this side being from four to five feet below the surface level of the surrounding stone. The channel dipped at a gentle angle to the south, and presented the general features and appearance of a deserted water-course; its surface was worn smooth to a remarkable degree, and was distinctly and deeply scored or fluted, all the lines being in the direction of its length.

The edges of the blocks of rock were completely rounded off and worn away towards the north, whilst in the opposite direction they remained comparatively sharp and angular, and exhibited but slight appearances of eroding action; it would therefore appear that the formation of this channel was due to the action of moving bodies passing over its surface in the direction thus indicated. Numerous boulders and pebbles, chiefly of limestone, quite distinct in appearance and quality from that which obtains in the district, were found strewn about in the hollow and on the surface of the rock. The stone worked in this quarry is compact, hard, and of a bluish gray colour, whilst the boulders are exceedingly tough, and difficult to fracture; on breaking, they are found to be of a dark brownish black; and to emit a strong fetid odour on being struck or rubbed, giving rise to the name "stinkstone," by which they are generally known. Specimens of the kinds of rocks I have laid on the table.

I am informed by Mr. Parker that rock of this character is found *in situ* near Gisburn, north of Skipton, and at other places lying to the north of Clitheroe. It is therefore evident that these erratics must have been transported from a more northerly, to their present position, by some force sufficient to effect the purpose. That this agent or force was not water alone, I infer from the fact that these blocks or boulders exhibited none of the characteristics of rolled, water-worn stones, but, on the contrary, that they retained their angular and rough exteriors to a considerable degree. This view is further borne out by the presence of the deep striations in the

rock channel, which could not by any means with which I am familiar, have been produced by the single agency of water.

Difficulties equally great present themselves in the attempt to ascribe the phenomena to glacial action. The depression occupies a space along the ridge or crest of the hill, which is the point of greatest elevation in the immediate locality. Towards the north, at a considerable distance, higher ground exists, leaving an intervening space between the two at a much lower level; consequently, to render tenable the view that these effects are due to glacial action, it would necessitate the supposition that an alteration had occurred in the relative level of the land, with an unequal upheaval or subsidence of its surface, subsequent to the existence of the glacier. Again, the breadth of the channel being so circumscribed, renders it additionally unsafe to attribute it to that cause. If then, we dismiss glacial action and water (*per se*), as the active agents in producing the effect described, we must, I conceive, look to the action of floating masses of ice or icebergs, as best meeting all the requirements of the case. This view seems also to be borne out in a paper "On Glacial Distribution of Granitic Blocks," read by Professor Phillips, at the recent meeting of the British Association, held at Bath, in which he shows that great numbers of various sized blocks, some very large, were transported from Wasdale Craig, over high and low grounds, across Yorkshire and the neighbouring counties. In tracing the course of the blocks, from the extreme south-east of Yorkshire back to their origin, it is found that they by no means follow the valleys and avoid the heights, but that on the contrary, with little or no difference, they occur alike on hills and dales, and reach the elevation of 1400 feet on Stainmoor, above the present sea level. The Professor further states, "that they seldom appear to have been rolled, yet, perhaps, by ordinary surface wear they have often become blunted at the angles," and he concludes, "that the distribution to such great distances, in directions not conformed to natural courses of drainage, can be best explained by the agency of floating ice, at a time when the ocean and land occupied relatively different levels from the present."

Mr. Hull, F.G.S., of the Ordnance Survey, and a member of this Society, has shown in the valuable papers he has produced on "The Millstone Grit of North Staffordshire, and the adjoining parts of Derbyshire and Lancashire," and on "The History of the British Coal-measures," and on "The New Red Sandstone and Permian Formations," that there is a gradual thinning away of the whole of these important formations as we proceed south-east, commencing at Lancashire and Cheshire as the localities in which they attain their maximum thickness. Many of the beds entirely disappear, whilst almost without exception those which are more persistent become gradually attenuated in that direction. And further, that the lithological character of the rocks undergoes a change, being found "coarser" and "more massive" where they are thickest, and gradually becoming "softer and finer" in texture as they thin away towards the south-east; thus distinctly pointing to the north-west as the direction from whence has mainly been derived the various substances which entered into the formation of these immense masses of rocks.

In further support of the theory of a northern current, I may point to the thick beds of gravel found, about four miles N.E. of Burnley, on the steep slopes of the valleys of Swinden and Thursden, reposing upon strata of the carboniferous age, through which flow streams collected on Boulsworth and the high grounds in its vicinity. This gravel is so fully charged with carboniferous limestone boulders and pebbles, as to have rendered their washing and sorting, for the purpose of burning into lime, a remunerative undertaking. The kilns used for that purpose were in operation at no distant period, and their remains may still be seen. The means employed for effecting this object, was a stream of water, which, being collected and impounded on the higher ground, was directed over the gravel previously loosened by workmen; this removed the earthy and clayey matter, and left the pebbles exposed and ready for sorting. The steep sides of these valleys, particularly of Thursden, where the workings have taken place, present a strange and confused appearance, innumerable deep channels having been

cut into their sides by the combined operation of workmen, and the action of running water; between these channels are thrown up numberless heaps of rejected stones and gravel, giving to the whole a wild and unnatural aspect.

From a consideration of all these facts, I am led to the conclusion that the formation of this channel, together with the striæ in its bed, have been effected by the continued action of moving bodies of ice, charged at their under surface with hard rocky substances, borne along by a current of definite direction from the north, at a time when the relative levels of the land and ocean were different from the present, and when the land at that particular place was slowly rising from the waters in which it was then submerged. This glacial current has left the record of its existence on innumerable rock pages, in characters too legible to be misunderstood, and so deeply impressed, that the immense lapse of succeeding ages has failed to obliterate it.

The thanks of the Society were voted to Mr. Aitken for his paper.

Mr. Chattwood—Is it not possible that that channel, mentioned in the paper, might have been an old water-course?

Mr. Parker—No, I think not. It was on the very top of the hill, and it did not appear upon the surface in one unbroken and continuous course.

Mr. Plant—The paper is a very interesting one, because of the evidence of glaciation on the western side of the Penine chain. After all, the very close examinations of Mr. Hull, of the Geological Survey, have not succeeded in producing more than one or two, and those very doubtful cases of glaciation upon the carboniferous series. There is a much better chance of striations retaining their

permanency upon limestone rocks, and it is mostly there, and in places where there are igneous rocks, that these marks have been preserved. I do not see anything in the mere fact of the mark running along the ridge of the hill to contravene the opinion that it must have originated from glacial action. The specimens upon the table are as good evidences of glaciation as those upon the boulders found in the till near Manchester. Every bed and portion of drift examined will be always found to partake of local rather than general characters, and I am prepared therefore to hear that the drift about Clitheroe partakes more of the character of the carboniferous limestone. This is one of the strongest evidences of glacial action that has yet been discovered on this side of the country. The millstone grit and coal-measures are evidently too soft to retain the markings which may have been made upon them, and that is why we do not find them upon the tops of the capping where the millstone grit is found.

Mr. Aitken, in reply to a question from Mr. Dickinson, said that the course taken by the striation he had mentioned, was almost north and south, with a little inclination to the north-west and south-east.

Mr. Dickinson—It is now about thirty years ago that I began as a pupil with a civil and mining engineer that this Society has made one of its Honorary Members—Mr. Sopwith. At that time the action of glaciers upon rocks was first brought under my notice, when Dr. Buckland, having taken the matter up as a sort of hobby, was scouring the country in all directions in search of what was then called markings by icebergs and glaciers. Mr. Sopwith accompanied the Doctor, and an amusing etching was made of them in their searches through the mining districts of the north of England. A few months ago, I was down in the Agecroft Colliery, and took from the roof of the coal a piece of shale showing scratchings, which had they been found upon the surface, would have been attributed by 99 out of every 100 to have been the result of an

ancient glacier. (The specimen was here exhibited.) I could show you acres of rock in mines far better striated than the specimens given by Mr. Aitken. I know the country to which he has referred pretty well; I have traced out the direction in which many of the large limestone boulders there are deposited. They have evidently come from the limestone formation, and are deposited in a southerly direction, like that of the crossings or groovings Mr. Aitkin has described, throughout the neighbourhood, but I see nothing to warrant anyone in coming to the conclusion that those erodings were caused by icebergs. I believe these are to be attributed to a far different origin from what is generally described. As geologists, we take far too contracted a view of the subject. We should go back to the time when all this matter was created before time began, probably billions of years ago, if it could be so estimated, and when it was all assimilating, and before the mass was broken up into the different planets which now form our hemisphere. Until we can take a grand view of the subject like that, we shall all be groping on in a very unsatisfactory manner.

Mr. Aitken said he did not contemplate for a moment introducing any new theory for the consideration of the Society to account for the occurrence of these striæ, his object had been merely to record facts. He was, however, unable to agree with Mr. Dickinson's view of the creation.

Mr. Dickinson, in reply to a question from Mr. Chattwood, said his view was exactly in accordance with what was laid down in Genesis as to the creation of matter, and the afterwards making of it into the world, and which entirely agreed with every observation he had made in geology. He went back to the beginning, when all the materials were one soft, watery, pulpy mass, which, with water plants, was assimilating together into the different strata, and which, when, what is called the making of the world took place, was broken up into the earth and planets. As the mass was being divided, and as one part left the other, there would be frayings, or rubbing of surfaces, by which the erodings now attributed to ice-

bergs might be formed, and boulders deposited in the same direction; in no other way can the denudation which has evidently taken place be so satisfactorily accounted for, nor the beautiful laminæ into which the strata are divided be so satisfactorily explained.

Mr. Plant said that the specimens of shale which Mr. Dickinson had produced, shewed what was known on the continent as the *slickenseid*. But the essential difference between that specimen and true glaciation, was that the lines in the former were not lines at all, but were only a series of small elevated ridges broken off and joined together again. In all glaciations, the cuts were as clean as if they had been done with a graving tool. Mr. Dickinson was never more mistaken than in his views on the creation, but what he had published in connection with the Society showed he was at heart a geologist.

Mr. Dickinson said he merely brought the specimen to show that all these groovings were to be looked upon with great distrust as having been formed by icebergs.

The following paper was then read:—

ON THE

OUTCROP OF THE LOWER COAL-MEASURE ROCKS ON BOULSWORTH AND GORPLE;

TOGETHER WITH OBSERVATIONS ON THE

ORIGIN OF SOME "ROCK BASINS" THEREON;

By Mr. Joseph Whitaker.

Along the high ridge of hills that separates the county of Lancaster from that of York, about six miles to the east of Burnley, the lower coal-measure rocks crop out in an anticlinal form, dipping to the west under the Lancashire, and to the east under the Yorkshire coal-fields. The bassets of the principal rocks form a series of parallel ridges, followed by corresponding trough-like depressions. These ridges and depressions have, no doubt, been caused by the

soft shaley portions of the strata being disintegrated to a greater extent than the harder and more durable rocks with which they were associated. Many of these bassets, from the sharp outlines that they present across the moors, have received the designation "Edge," such as Wasnup Edge, Hazel Edge, &c.

The highest of the above ridges, which has been formed by the millstone grit being upheaved and thrust wedge-like through the overlying coal-measure rocks, includes the Boulsworth, Gorple, and Black Hambledon Hills, which rise severally to a height of 1700, 1530, and 1570 feet above the sea level. This mass of gritstone, which seems to have been the centre of the upheaving force, takes the form of a narrow belt. It commences at the Bride Stones, in the township of Stansfield, Yorkshire, where its farther continuation to the south is cut off by the Todmorden valley. Thence, curving to the north, it passes by the Hawk Stones, to the Hoof Stones, which form the boundary between the two counties. Then turning a little to the south, it passes by the Gorple Stones, and on to Lad Law, where it forms the crest of Boulsworth, at a height of 1700 feet. From Lad Law, it takes a decided turn to the east towards Haworth, in Yorkshire, where it is covered by the lower measures of the Yorkshire coal-field. The above belt of rock, which lies nearly horizontal, its dip being inconsiderable, forms the geologic *back bone* of the district, against which the superior strata abut, and from which they slope off on each side, dipping at various degrees of inclination.

The next ascending basset, which is that of the highest portion of the millstone grit, commences on Hanson Fold Hill, at a height of 1200 feet, passes in a southerly direction by Small Edge, along Standing Stones height, crosses the Long Causeway at Stiperden, and overhangs the Todmorden valley on the top of Wittenstall. Resting upon the above rock, a series of finely laminated black shales occur, containing two or three thin seams of coal. These shales are exposed in the higher part of the Swinden water-course, where one of the coals has a very strong gannister seat. They also

basset in Stiperden, where the thickest of the coals has been worked; the roof of which contains shells of the genera *Goniatites*, *Aviculo-pecten*, &c., together with fish remains; they also crop out in a similar position on the north, or opposite side of the "Burnley Basin."

The "Great Flag Rock" is the next in the ascending series. It is closely followed by the Rough Rock; both of which, together with the Featheredge coal, are well exposed in the Swinden valley, dipping at an angle of 35°.

The strike of the Rough Rock, which is from the north-east to the south-west, after crossing the Thursden valley at Great Rieve Edge, passes by Middle Edge, crosses the Swinden valley above the reservoir of the Burnley Water Works, then along Wether Edge, to Pike Stones Ridge; from thence, by Shedden Edge, it crosses the Long Causeway under the site of the Duke's Cross, where the Featheredge coal is exposed to view, dipping at an angle of 48°. It then crosses Stiperden, at Shay Clough, and terminates at Reddie Shore, one of those precipitous cliffs that add so much to the stern beauty of the vale of Todmorden.

The Rough Rock is succeeded by black and dark blue shales, parted by thin bands of stone. These shales contain shells of the genera *Goniatites*, *Aviculo-pecten*, &c., lying about four yards above a thin seam of coal. This coal, which is of inferior quality, has been worked on Great Edge, in the Swinden valley, where it is 18 inches in thickness. Resting upon the last mentioned shales, at a distance of about 20 yards above the Swinden coal, the Monk Hall Rock is met with. This rock, which is the equivalent of the Woodhead Hill, and Lomax Wood Rocks, is being extensively quarried at Monk Hall, Delph End, and at Worsthorn quarries. To the west of the Worsthorn quarries, the farther continuation of the lower measures is interrupted by the occurrence of a large fault running nearly north and south. This fault, which cannot be less than 1000 feet, is a down-throw to the west, and brings in the Arley series of

mines, which are being worked near the village of Worsthorn. The above lines of basset edges follow each other across the country for several miles with marked regularity, from Boulsworth, near Colne, to the vale of Todmorden, where they are intersected by the great lines of fracture that traverse the southern boundary of the Burnley coal-field.

The district that I have attempted, geologically, to describe in the foregoing remarks, consists almost exclusively of wild and uninhabited moorland. The undulating swells of the heath-clad hills, being relieved only by an immense number of massive rocks of gritstone, protruding from and standing out in bold contrast to the sea of heather with which they are everywhere surrounded. Some of these masses of gritstone are yet *in situ*, others have slid from their bases and rolled down the declivities they once overhung, whilst a great many stones are scattered indiscriminately up and down the commons. Many of these stones are objects of great curiosity, on account of the peculiar, and even fanciful forms, into which they are weathered at Gorple; the mass of stone represented in fig. 4 stands alone, and to all appearance detached from the surrounding rocks. In form it is not unlike some of the Cornish Cheesewrings, but much smaller in size. The Dicken Stones are a very interesting group. One of them is a loggan, or rocking stone, it measures 11 feet in length by 4 feet in breadth, and, though several tons in weight, can be easily swung to and fro, with the finger. This stone differs from most other loggan stones, inasmuch as it rests upon two points, or pivots, and swings cradle-like, from side to side. In this group also is to be found the largest detached stone of the district, and there are not many larger stones to be met with in any part of the country; it is 20 feet broad, 30 feet long, 19 feet in height, and contains 11,400 solid feet of stone. Originally, the Dicken Stones have presented a compact face of rock, split up by vertical joints into blocks 6 or 8 feet in breadth, and from 20 to 30 feet in height. Some of these blocks, have fallen from their positions, and left the intermediate ones standing in rude resemblance to a line of massive square pillars.

The groups known as the Bride Stones and Hawk Stones, too, afford some curious configurations. There is one called the Great York Stone, which consists of two stones laid one upon the other. The uppermost, which projects several feet over at each end, has three large cavities on the top of it, each of which is worn out through the side of the stone. There is another called the Bride; its height is about 15 feet. Its diameter, which is about 12 feet near the top, gradually diminishes towards the bottom, where it is not more than 2 feet. Near it, stood another, called the Bridegroom, which is now thrown down. In Watson's History of Halifax, it is stated that the Bride Stones, "from their shape, size, situation, and other circumstances, afford grounds for supposition that the Druids had here a large settlement," and that there is "a vast variety of rocks and stones so scattered about the common, that at first view the whole looked something like a temple of the serpentine kind." That there are a great many rocks and stones cannot be disputed, but anything like systematic design in their arrangement is wholly imaginary; for neither here nor at any of the other groups is there a single stone that can be fairly said to be artificially set up.

On Lad Law there is a very massive stone, 13 feet 5 inches long, which projects over the side of the hill in a very commanding manner. The view from the point on which this stone stands is very extensive, embracing as it does, nearly all the principal hills of the Penine chain, from the Peak in Derbyshire, to Great Whernside on the north-western limits of Yorkshire.

There are many other highly interesting masses of stone on different parts of the adjacent moors, besides those above enumerated, concerning which it is not my intention to do more than give the names and localities of the principal groups. On Boulsworth there are the Joining Stones, the Saucer Stones, the Chair Stones, the Steeple Stones, the Wool Stones, the Broad Head Stones, the Standing Stone, the Dew Stones, the Raven Stones, the Crow Stones, the Habit Stone, the Cow Stone, &c. On Gorple there are the Hanging Stones, the Gorple Stones, the Hare Stones, the

Nooning Stone, &c. On Black Hambledon there are the Whinberry Stones, the Hoof Stones, &c.

An interesting feature in connection with the rocks and detached stones of the Boulsworth district, is the occurrence of a great many rock-basins or "pan-holes," as they are called by the country people, which are numerously distributed upon the exposed surfaces of all the principal groups of rocks, as well as upon many of the single blocks that are scattered up and down the moors, some of which have as many as 16 or 17 upon them. These and similar cavities found in other parts of the country, have generally been regarded as the works of man, and their formation and contrivance have been ascribed to the Druids by many local antiquaries, some of whom, with singular temerity, have designated the purposes for which they were used, such as the holding of blood, oil, wine, water, &c.

A geological paper is perhaps not the proper place to enter into the historical part of the question, but I think it will be found on examination, that the evidence afforded by history, in favour of the Druidic origin of rock-basins, is but very scanty. Dr. William Borlase seems to have been the first person to give currency to the idea, in his Antiquities of Cornwall; but as that work was only published in 1754, it is not very likely that much more was known concerning the Druids then than now. Neither Tacitus nor Julius Cæsar make any mention of them in their description of the manners and customs of the Druids, and as they lived at the same time as the Druids, and had ample means of making themselves acquainted with the religious rites of that people, and as they were fully capable of describing what they saw, it is only reasonable to assume, that they would have left some intimation of the fact, if rock-basins really had been in use by the Druids as represented.

During a careful examination, however, of all the rock-basins found in the district specially under notice, I have been driven by the following reasons to the conclusion that they are of natural formation, and that they have not been systematically made for any

purpose whatever. Firstly their numbers—lying within a distance of two or three miles of each other, there are not less than seven or eight hundred of the kind usually denominated rock-basins, besides a multitude of nondescript holes, cavities, and indentations of no particular shape; and to my mind it is hard to conceive of what possible use so very many could be so near together; the great bulk of them being, in fact, within sight of each other. Again, their situation is not such as to warrant the conclusion that there has been anything like design in their arrangement, for they are found to be quite as numerous upon the stones that are laid flat upon the common, as upon those which occupy more prominent and commanding situations. Some of them, too, are so placed upon the ends and sides of the rock, as to preclude the idea of their having been of any definite use.—Figs. 1 and 2. Their gradation in size, too, which is from the smallest indentation up to the largest rock-basin, five or six feet in diameter, is scarcely consistent with the idea of one uniform design. Neither are they by any means so regular in shape as they have been represented, for, although most of them are somewhat round, very few of them can really be said to be circular. The quartz pebbles, also, which are thickly interspersed through the gritstone, are found standing out from the sides of some of the basins; one in particular, projecting half an inch from the side of one of the basins on the Dew Stones, clearly pointing to some slow, but regular process of wear.

But the most convincing argument against the artificial origin of the rock-basins, is furnished by the fact of nearly one third of their entire number being worn out at the sides of the stones on which they are formed; for it is hard to believe that any artist, Druidic or otherwise, would pitch the centre so near the edge of the stone that, in forming his basin, he would have to work himself out at the side, and make it that it would hold neither blood, wine, water, nor anything else. But perhaps it might be objected by the supporters of the artificial theory, that these basins have worn their way through the sides of the stone since they left the hands of the Druidic workman. But if the principle that these basins are

continually increasing in size be admitted, then we have the conviction forced upon us, with regard to the small ones, that they, at least, could have had no existence in the days of the Druids, notwithstanding that they are equally as numerous, and quite as symmetrical and circular (if not more so) as the large ones; because, if they had been all made at the same period of time, and for the same purpose as we are expected to believe, then they, the small ones, would inevitably have got larger the same as the others, for it is altogether absurd to suppose that one class of basins would so increase in size as to wear through the side of the stone on which they were sunk, whilst others upon the same stone would remain stationary in size at a diameter of one or two inches. But I apprehend the true explanation will be found to be, that fresh ones are ever beginning, that the small ones are continually increasing in size, and that the large ones keep wearing through the sides of the stones on which they are sunk, and that the same process will go on until the blocks of gritstone are reduced back to the native sand from which they were formed.

The millstone grit of the Boulsworth district contains a considerable quantity of iron ore distributed throughout the rock in nodules and thin veins. These veins, which vary from mere red streaks up to bands of two or three inches in thickness, give to the rock, when newly broken, a variegated appearance; some of these veins, by taking a circular form, have enclosed masses of gritstone of various diameters. These enclosed masses of gritstone, although not exactly ironstone nodules, seem nevertheless to be to a certain extent of a concretionary nature. They vary considerably—some of them being harder, others softer than the adjoining rock; where harder, the weather has left them protruding above the surface of the stone, but where softer than the rest of the stone, they have disintegrated into hollows, and have thus contributed to the formation of some of the basins, as is clearly shown by their limits being defined by a red circular band of ferruginous matter. One of the stones on Gorple is worthy of special notice, in consequence of its having upon its surface a shallow basin 29 inches in diameter,

which is evidently in process of formation by the breaking up of one of the above-mentioned concretionary masses into thin concentric *laminæ*. But the agent that has most contributed to the formation and enlargement of these basins, is the water with which they are constantly filled during the wet season of the year. This water, by first lodging in the irregularities and hollows on the surface of the gritstone, has set up special centres of decay. The tendency of this decay, by acting from a centre, and radiating equally in every direction, is to enlarge the indentations in a circular manner, and thus produce the round forms that so many of the basins present. This action of the water is very perceptible in many of the basins, which, when full of water, are surrounded by a circular zone, into which the water has so far penetrated as to give it a wet appearance when all the rest of the stone is dry. These saturated zones, which faithfully follow the contours of the basins they surround to a distance of several inches from their margins, show conclusively that, as far as they extend, the water has already partially disintegrated the stone, and thus prepared the way for the permanent enlargement of the basin.

When the above described partially disintegrated zones extend to a lower part of the stone than that on which the basin is sunk, the water (strange as it may appear) actually oozes through the side and runs out of the basins before it reaches the level of their edges, and I have no doubt but that the channels leading from some of the basins have been formed in this manner. In addressing a scientific assembly it is useless entering into any arguments to show what effect the weather will have upon the saturated part of the stone when a wet season is followed by a sharp frost, as is often the case during the inclement part of the year. But the water not only acts when at rest, but it also acts, and with much greater effect, when in motion. The wind in blowing against the sides of the basins is deflected from its course, and, by impinging upon the surface of the water, imparts to it a circular motion. By placing a light substance upon the water, this motion may be seen during the continuance of the mildest breeze, but it is much more perceptible when impelled

by a strong wind. The water is then kept in one incessant whirl, and the rotatory force thus created, in a heavy storm, is sufficient to carry up the water from the basins in a spiral form, and scatter it over the adjoining common.

The effect of this continued gyration of the water, is to wear down all the hollows, no matter what their original shape, into forms approaching the circle, for any inequalities that there might be in their contours, by projecting into and thus impeding the free flow of the water, would be subject to a greater amount of friction and consequent wear, than the parts not so projecting.

Two or more basins are often situate near together, upon the same stone. When such is the case, and a strong gale is blowing in a direction coincident with the line in which they lie, the water is driven by every sudden gust of the wind from the one basin to the other, running back to its ordinary level during the momentary lulls that occur, but only to be again pushed up by the next rush of the storm, and thus the water is kept alternately passing from one basin to the other so long as the tempest lasts; and from what I have seen of this peculiar motion of the water, I have not the slightest hesitation in giving it as my opinion, that the "grooved channels" from one basin to another, (which have been looked upon as so very important by some antiquaries) have been formed in this manner.

That these rock-basins are singular and curious, I am free to admit. But of the multitudinous works of nature, it is only to be expected that some of them should appear out of the common line, and after repeatedly visiting all the principal groups of stone, and closely inspecting the different basins upon their surfaces, and after carrying on a series of observations, through all kinds of weather from the mildest zephyr to the wildest tempest, I am persuaded that the rock-basins are natural in their origin, and that they are the result of atmospheric causes, acting upon the stones through a long course of ages; and with regard to the various groups of rocks and basins in the Boulsworth district, I can fully adopt the language

of Dr. Paris, as used in reference to those of Dartmoor, "that the only chisel ever employed has been the tooth of time, and the only artist engaged, the elements."

The thanks of the Society were given to Mr. Whitaker for his Paper.

Mr. Baldwin called attention to the manner in which similar holes to those mentioned in the Paper were made in the rocks at the sea-side, and in some running streams, like the Wharf, by pebbles, or the whirling motion of the water.

Mr. Whitaker said that the difficulty in the present instance was to get the sea up to the height of 1,700 feet. No doubt new basins were being formed every day by elementary action.

Mr. Dickinson said he knew the millstone grit very well in Cumberland, Northumberland, this district, Staffordshire, and North Wales, and there was always the peculiar characteristic through the entire range that it had rocky projections and caverns about it, which he had always attributed to atmospheric changes. He was very glad to find that Mr. Whitaker did not attribute them to the chisels of the Druids.

Mr. Whitaker said he had examined nearly 700 of them, and there was not one which he could say was artificially produced.

Mr. Plant said that Mr. Hull had given as his opinion in reference to some features of this subject that they were the evidences of the old coast line in this part of the island. These characteristics detailed by Mr. Whitaker were the constant accompaniment of the high millstone grit, and there could be no doubt in the minds of those who had examined them that they were produced by nothing but atmospheric action.

A vote of thanks was passed to the President, and to Mr. Dickinson, who had presided during the latter portion of the proceedings, and the meeting terminated.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 6.] VOL. V. [Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday afternoon, March 28th, 1865.

ANDREW KNOWLES, ESQ., President, in the Chair.

Mr. Livesey, of Hollinwood, presented to the Society a number of Photographs of the interior of a coal mine, taken by the magnesium light.

Mr. Wild presented to the Society a specimen of Fossil Wood taken from the Blendfire rock, Glodwick, where the rock is 48 yards thick. The piece of fossil from which the specimen was taken was 15 feet long, and crooked, like the branch of a tree. With reference to the specimen exhibited, Mr. Binney said it was a fine specimen of wood, showing good structure, and possessing apparently annular rings not commonly found in wood taken from the coal measures.

The thanks of the Society were given to Mr. Livesey and Mr. Wild for their contributions.

Mr. R. D. Darbishire, F.G.S., referred to Mr. Plant's remarks at

the last meeting of the Society respecting the frauds going on at Macclesfield, having for their object the foisting of many recent shells of British or foreign origin upon collectors as fossils from the gravel beds, and even the manufacture of spurious fossils by treatment of recent shells with fire and acid, and shaking amongst gravel, to give the necessary red tinge,—frauds said to have been successful at the Museums of London, Manchester, and Liverpool.

He had given great attention to the Macclesfield fossils during the past year, and was convinced, not only of the genuineness of a very large series of remains, but of their peculiar interest; and believing that Mr. Plant's statement was calculated to throw discredit, even to a far more serious extent than the forgeries themselves, upon those specimens which are veritable fossils, laid before the Society a list of the specimens he believed to be genuine, with evidence in vindication of their character.

He described the shell-bearing gravels of the drift generally, with especial reference to the beds at Moel Tryfaen, Caernarvonshire (see proceedings of Manchester Lit. and Phil. Society for November, 1863, and appendix to edition 3rd of Sir Charles Lyell's Antiquity of Man), and to the beds in the cliffs, near Blackpool (see Transactions of the Manchester Lit. and Phil. Society, Vol. X., 1851-2), and exhibited large series of shells and fragments of shells, undoubtedly genuine, from each locality.

The Macclesfield Cemetery beds precisely corresponded in position and character with the Welsh and Lancashire deposits. Similar beds occurred in several places about the Macclesfield district. One remarkable patch had been identified by Mr. Prestwich, F.G.S., at a height of about 1150 feet above the sea, on the Buxton Road. During the Cemetery excavations a very large extent of gravel had been exposed, and many shells and fragments of shells found. Mr. J. D. Sainter and Mr. Lowe had collected zealously, buying from workmen in addition to their own gatherings. These speci-

mens having been first submitted to gentlemen of the Geological Survey, certain spurious ones were at once noted. Since August, Mr. Darbishire had repeatedly examined the whole of those collections. There was no doubt that many shells had been passed off by workmen, which had nothing to do with the Macclesfield drift shells, from foreign or recent British shores. But very few indeed of this class were such as could for a moment deceive anyone really skilled in recent and fossil conchology.

As to the statement that drift fossils were counterfeited, Mr. Darbishire stated that the Macclesfield specimens (of which he exhibited a large series as genuine, including collections belonging to Mr. Sainter and himself) precisely represented many pounds weight of similar fragments he had handled at Mr. Lowe's, and moreover, with all but equal similarity, similar masses of the Moel Tryfaen fragments. Again, the Macclesfield group of fossils reproduced with remarkable correspondence the Moel Tryfaen and Blackpool lists, and that, not only as regards the particular species, but even the relative proportions of frequency. Further, the Macclesfield fossils continually repeated the conditions of fracture, wear, and preservation, which characterize the Welsh and Lancashire remains. Supposing that the Macclesfield Navigators could conduct a delicate mechanical and chemical process to the minute point of exact imitation, it was out of the question that any one of them should know exactly what species to use, or how to break and wear them to the genuine drift pattern, or how to mix them in true drift proportions. It was impossible that they should introduce certain arctic shells now extinct, or certain southern shells of extreme rarity in English seas. There was moreover a remarkable absence amongst the Macclesfield fragments of specimens of many of the commonest beach shells. Lastly, the shells and fragments were not so rare as to make it worth while to counterfeit them.

On the whole, Mr. Darbishire believed the charge of fabricating spurious drift fossils altogether an invention; that it was so, one

remark of Mr. Plant's informer seemed to prove. The author of the statement said that fragments, specially prepared with a coating of white lime, were shaken in a basket with gravel to give them the necessary red tinge. How the rubbing could be continued without removing the white lime was doubtful; but, after all, instead of having a red tinge, it happened that these fossils have a peculiar and constant creamy white colour. The redness was the result of the storymaker's own confusion between "gravel," according to the ordinary notion, and the bright clean sand and shingle of the Macclesfield shell-bearing drift. That certain frauds had been more or less clumsily perpetrated was certain, but they were not such as to impose on any skilled and wary observer.

Mr. Darbishire had dwelt so much on the subject because the doubts cast upon the genuine fossils by charges of fraud, unaccompanied with any notice of their extent and limitation, required especial detail for their removal. The effort was the more needful as the most remarkable fact in connection with the Macclesfield fossils was the occurrence of certain species of southern type, a circumstance so new as to challenge the closest enquiry, even had there been no suggestion of fraudulent endeavour.

It was just to the Curators of the Geological Museum in Jermyn Street to point out that they were the first to indicate the presence of spurious specimens, and to those of both the Liverpool Museums, that neither of them had even seen the Macclesfield specimens. The Manchester Museum had certainly not been deceived.

Mr. Darbishire then exhibited in detail his own series of Macclesfield fossils, and Mr. Sainter, who was present, showed his series of selected specimens.

The complete list of shells comprized 51 species, as to a few of which the suspicion caused by the intrusion of recent shells raised some doubt whether the particular specimens were genuine or not.

The most remarkable species were *Cytherea chione* and *Cardium rusticum*, both shells of characteristically southern origin. Of each, Mr. Darbishire had himself taken fragments on the spot, which he showed with others from Mr. Lowe and in Dr. Sainter's series. There was no mistake about the genuineness of either of these fossils.

Mr. Binney exhibited his collections of drift shells, made at Blackpool, Hollingworth, near Glossop, and Rainford.

The thanks of the Society were given to Mr. Darbishire for his paper.

Mr. Plant.—As the remarks I made at the last meeting have been almost accepted as a challenge respecting the genuineness of the finds in the Macclesfield drifts, I feel that I am called upon to make some further observations upon the subject. I did not trust to my mere recollection for what I said at the last meeting, for I read my remarks from a manuscript purposely to guard carefully against implicating myself in speaking of the whole of the finds in the Macclesfield drift. My information came to me in such a manner, and accompanied with specimens of shells that had unmistakably been manufactured by being soaked in acid, that there could be no dispute whatever about the specimens. I have given them away, but those I have now were procured by a friend at Macclesfield, who has accumulated them within the last three months. From last September I have expressed to him my doubts as to the genuineness of the specimens. The specimens I have received recently are of the same character, and I feel more convinced than ever, especially since I have seen Mr. Darbishire's specimens, that many are not genuine, and that the men are still disposing of shells that cannot belong to the same drift deposit as

these of Mr. Darbishire's own collection. It appears that the authorities at the Jermyn Street Museum were really the first to detect that frauds were being made in the neighbourhood of Macclesfield. I have an extract from a Macclesfield paper which shows that in September or August these frauds were known in the locality, and that the men were palming off spurious specimens upon a local collector. He was very assiduous in collecting, and therefore the more easily imposed upon. I am assured that many of these spurious specimens have been sent to London, Manchester, and Liverpool. I do not see but that Mr. Darbishire has thoroughly established what I stated, namely, that a great many fragments of true fossils have been found in the drift at Macclesfield, and that spurious specimens have also been acquired. I think we need not question for a moment the ingenuity of these manufacturers at Macclesfield, or that the man who could invent this fossil in the oolite, would be well able to put half-a-dozen shells in the fire, soak them in acid, and manufacture them in the way described.

Mr. Darbishire said the misfortune was that Mr. Plant's strictures upon the false fossils damaged the reputation, to a serious extent, of the true specimens.

Mr. Binney—Having paid attention to these deposits for some 24 years, and as I feel a good deal of interest in the genuineness of some of the specimens, I have brought here the collection which I made at Blackpool, and a list which I published in the Philosophical Society's transactions many years ago. You may see there what caused me some six or eight years' collecting, and every one of those specimens was taken with my own hands out of the clay or the sand or gravel; a good many of them came from the till, and some from the gravel. If it took me that time to get together such a small collection, how much must I be pleased to see Mr. Darbishire's superior collection, and hear the paper which he read at our Philosophical Society last November. He at that time distinctly stated that there were a good many spurious shells, and he brought forward

t of true, a list of spurious, and I think a middle list which ned doubtful. I have long had no doubt that if people will and publicly offer a good price, they can always induce specimens to be found. Every collector must have had plenty of jokes played off upon him or attempted. In the lias district you may see an ammonite provided with a head and tail, so as to resemble a snake, simply because people will buy it; so any gentleman may get these drift shells if it is known he is ready to purchase them. But real geologists do not go to work that way; they will go and get their specimens out with their own hands, and be able to verify them themselves. What I find fault with is that, after a gentleman has taken very great pains to go and examine these specimens, and to find out two very remarkable species, showing the Mediteranean character of the shells, and which I know from experience in London and elsewhere, have created more interest than any other fossils found in the drift deposits,—what I find fault with is that statements should be made at a Scientific Society of a plan for manufacturing specimens, and sent out to the public, because it invites people to make fools of us. If I had been here at the time I should have protested against any plan being published of humbugging philosophers. Now these things have been published, I have no doubt we shall have many attempts to play tricks upon us, although I have never found a plain working man attempting these tricks. It has usually been one dealer or collector trying to cheat another.

Mr. E. Hull—I quite concur in the views expressed by Mr. Binney. It is very fortunate indeed, for the credit of the Society, that we have had the explanations from Mr. Darbishire, called forth by Mr. Plant's paper, a report of which I saw in the *Times*. It is not often the *Times* takes notice of a country Society, and no doubt it was very glad to have an opportunity of ridiculing such a Society. I am glad however it has called forth such a carefully argued, and well prepared paper, by which the evidence as to the genuine character of the shells may be determined. It is always

well to have, if any of us are napping, a kindly and gentle hint if anything underhand is going on; but I do not think it necessary to publish it to the world. But if this discussion has the effect of putting an end to the imposition that has been going on in Macclesfield it will do no harm, although it is easier in all things to get than to remove a bad name.

Mr. Dickinson—It seems from the way in which this matter has been brought before the Society, and the way in which some members have taken it up, that some little feeling exists. It has been clearly admitted by Mr. Darbishire that the collector who supplied specimens to the Jermyn Street Museum has been attempted to be imposed upon. I heard Mr. Plant's paper, and there was nothing in its contents but an account of what had actually taken place. To-day we are put into possession of further facts relating to these specimens, showing that, in addition to the spurious, there are a number of genuine shells. And that I believe was never disputed; on the contrary it was admitted that some had been found, while it was stated that some had been manufactured to meet the demands of the market. I look with the greatest interest upon these discussions amongst gentlemen who take an interest in the Palæontological part of Geology, because the more I see of it, the more firmly do I become grounded in the view that our fossils are only to be taken as a good general guide, but not as an infallible guide. From the reports of the proceedings of other Societies I see that the same important admission has been often made—that certain rocks which were pronounced barren of fossils have, upon the authority of Sir Roderick Murchison, recently been admitted to contain these fossils. Nothing but good, I am convinced, can come of this close scrutiny, and we are indebted both to Mr Plant and Mr. Darbishire for the facts they have brought before us.

Mr. Darbishire disclaimed having the slightest personal feeling in bringing his paper before the Society.

Mr. Aitken said the Society ought to feel obliged to Mr. Plant for having exposed frauds which Mr. Darbishire himself admitted. The only difference between the two statements was that, perhaps Mr. Plant had made rather too sweeping a statement as to the manner in which these frauds were carried on. No doubt spurious shells had been sold, and the practice might have been carried on to a great extent.

Mr. Binney.—As a collector of 25 years standing, I think if this Society is going to publish ways of deceiving geologists, collectors will not come here. It is giving a premium for deceit.

Mr. Plant said the best thing that could be done was to publish these frauds to the world. No one could suppose that a palæontologist would be taken in by a spurious fossil. It was those who collected for mere amusement, and for the procuring of pretty objects who were taken in.

Mr. Dickinson said that the spurious fossil, imbedded in oolite, which Mr. Plant had exhibited, was so well done that it was almost impossible to detect it.

Mr. Greenwell said that according to the tendencies of some of the remarks that had been made, it appeared that those gentlemen in future ought to be considered as doing wrong who detected frauds of any kind, even ordinary adulterations. His advice was let every fraud and every adulteration be published to the world, and there would then be a chance of frauds being put an end to. Exposure was the best, the only prevention.

The President said that there always must be two sides to a question, and he hoped the different sides taken upon this question would be productive of great benefits. He rather agreed with Mr. Binney that the Society was not bound to hunt after frauds. There always had been quackery in everything, and there would be quack-

ery in geology. But it would have no ultimate bearing upon the science itself; true geology would stand its ground in spite of frauds. Nevertheless good would come from this discussion, and the members could not but be pleased with Mr. Darbishire's paper and specimens.

Mr. Sainter, of Macclesfield, who had been introduced to the Society, read a paper upon the Macclesfield drift shells, and a description of some *Fulgurites* recently found in a sand-pit at Macclesfield.

MACCLESFIELD DRIFT SHELLS, &c:

By Mr. Sainter.

For the last two years extensive operations have been carried on in the neighbourhood of Macclesfield, in the formation of a new Cemetery. It comprises about 25 acres, and consists chiefly of the marine drift deposits. At its southern extremity there is a valley about 100 feet in depth, with a sloping ascent extending northwards to about 600 feet; and during the process of draining and levelling the ground, the nature and character of the strata, &c. were thoroughly exposed. Commencing from the brook upwards, we have first the boulder clay which forms its bed; it is of a dull reddish brown colour, very firm and tough, and is extensively used about Macclesfield, in the manufacture of tubing, bricks, &c. The valley gravel overlies this clay, and it consists of soil, sand, gravel, and pebbles—also soft clayey loam and patches of peat-bog, the latter being of variable thickness, from a few inches to six or eight feet. Trunks of trees, chiefly fir, oak, beech, and hazel were dug out of it; likewise some acorns and nuts. Connected with the brook, deep drains were cut diagonally at different levels on the hill side, to the height of 30 feet. These cuttings developed thick

unstratified beds of wet and dry sands and gravels, with clayey loam, of varied consistence and colour, the latter chiefly ochreous; likewise a few detached masses of boulder clay; and the whole series were pretty well packed with pebbles and boulders, and rough pieces of rock of all sizes and character. With the exception of those embedded in the till or boulder clay, nearly all the rest have been derived by subsidence from the higher levels as the valley became gradually formed; and here some very large blocks of granite and porphyritic greenstone were dug out. At the above height, tramroads were laid one above the other, at intervals across the acclivity, and all the deposits were laid bare, and cut into in all directions by the workmen. The exposed surface occupied an area, extending east and west, to about 500 yards in breadth, and 60 feet in height, with a southern incline of about 500 feet; at this elevation the alluvium was about eighteen inches thick, and below it, for three or four yards, the interval is filled up by a deposit of ferruginous soft clay or marl, mixed with coarse sand or gravel, and the whole is crowded with waterworn pebbles and boulders, and irregular masses of rock, apparently of almost all ages, sorts and sizes, and from all quarters of the compass. Below these accumulations the stratified beds appear, and they consist generally of both fine and coarse sand and gravel, with shingly pebbles, and some thin clayey beds, with a few small seams of coal or shale; and although for the most part the orders of stratification are even and regular, yet in some places there exists oblique laminations with occasional curvings, and also intercalations of false and current beddings. There occurred likewise some remarkable vertical and diagonal interruptions, or intrusions of very fine, clean and bright running sand or gravel of a light brown color.

Perhaps the most remarkable result attending those excavations has been the discovery of a large quantity of marine shells. In other parts of the country these have been frequently met with, but probably there are few places where they abound so much as in this vicinity. They are to be traced round the town and on the

hills to an elevation of 1200 feet. In the Cemetery ground they make their first appearance about ten or twelve feet below the surface, and for about fifty feet there is scarcely a bed of sand or gravel free from their exuviæ. Those that are found in clean sand or gravel are almost perfectly white, while others in clay partake of that colour. In the collection of shells brought here for your examination, above half the species were found in a fragmentary condition, and of these fragments some pounds were collected, but the greatest majority were too defaced to be indentified. The *Turritella* and *Cardium* were the most plentiful, but very few indeed of these, in comparison with the number of their fragments, are perfect. The above, and the *Patella*, *Purpura*, *Mangelia*, *Pecten*, *Fusus Bamfius*, *Ostræa* and *Tellina*, were the first met with, at about three yards below the surface, embedded in fine stratified sand or gravel. At about ten feet lower down, nearly thirty varieties were found in almost a perpendicular bed of fine and even running gravel. This bed proved to be ten or twelve yards in depth, about fourteen in breadth, and four or five in thickness. The most perfect specimens were taken out here than at any other part of the ground, especially *Murex*, *Nassa*, *Purpura*, *Littorina*, *Dentalium*, *Venus*, *Mactra*, *Natica*, *Trochus*, *Turritella Aporrhais*, and *Cardium*. The floor of this bed was a thick stratum of rather wet sand. At this point the shell deposits appeared to terminate; and it was the lowest level reached by the labourers above the drainage operations before described. On the same horizon' as above, at a short distance eastward, in a small bed of fine running gravel, four or five *Cypræa Europæa* were found in a perfect condition; likewise the *Cyprina* fragmentary, and a large *Buccinum undatum* in very good condition. But some of the larger shells are indebted to their preservation from their being embedded in a more clayey medium. Each separate cutting presented more or less a change in sorts; but the most fragmentary and universally distributed proved to be the *Turritella*, *Cardium*, *Tellina*, *Mactra*, *Buccinum*, *Mya*, and *Cyprina*. In a thin bed of fine sand, upon an upper level, there were found some very minute shells in a wonderful state of preser-

vation, viz:—young of the *Turritella*, *Nassa*, *Mangelia*, *&c.* These beds of fine sand and gravel were the most prolific.

Not much less striking than the discovery of those shells is the circumstance of the extraordinary quantity and variety of rock-specimens, &c., which have been associated with them. The boulder clay of this neighbourhood contains, I believe, upon the whole, about the usual number of igneous rocks which are found in it elsewhere. Although, at the southern extremity of this town, there are some very fine beds of it, entirely free from pebbles and everything else, except pieces of drift-wood and fragments of coal. In the Cemetery ground, the greenstones predominate in the boulder clay; next come the granites, felstones, porphyrys, &c., the whole more or less polished, scratched, or grooved. Blocks of quartz rock are sparingly seen, but pebbles of it abound everywhere, and of endless design and colour. Two or three smaller specimens were picked up as transparent almost as those from the Brazils. But it is the bed about two or three yards in thickness, immediately below the alluvium, that contains the greatest variety of rock specimens, both foreign, native, and local. Besides containing the igneous rocks similar to those in the till, and also others of like nature and character, still the carboniferous and silurian grits and sandstones supersede all the rest.

I will now refer to some of those specimens lying before you of the local drift, which extends for a few miles about Macclesfield, since they are very conspicuously represented in the above bed, viz:—rough pieces of Millstone grit, (chiefly specimens of the third, fourth, and fifth beds); and also those of the Yoredale rocks, all from the adjacent hills lying eastward.

The Millstone grit and Yoredale series attain a thickness of about 2500 feet in this locality; likewise, from the same district, specimens of the lower coal-measure sandstones, containing fossils, viz: *Sigillaria*, *Stigmaria*, *Calamites*, *Coniferæ*, *&c.*; also detached pieces

of coal, and blocks of gannister—sandstone, with impressions of *Stigmaria* and reed-like plants, and lumps of fire-clay studded with fossils.

From the neighbourhood of Buxton, twelve miles, carboniferous limestone generally in a nodular form, of all sizes, well waterworn, and very plentiful, containing fossil shells; likewise rough pieces of the same, composed entirely of *encrinital* stems, also lumps of *madreporæ*, *corallines*, and a few *turbinolia fungites*.

Specimens of the second Bunter and Permian sandstones; the nearest point to Macclesfield, where the former crops out, is at Bollington, four miles north-east; and both appear at Rushton, seven miles south. The second Bunter passes under the town, with a north-westerly dip, at about 25 yards in depth, overlaid by the drift and debris from the adjoining hills.

From Alderley Edge, five miles north-west, specimens of the lower Keuper conglomerate sandstone, and the green and blue carbonates of copper ore; very large masses of the latter were found just below the alluvium. From the same hill likewise, the brown and yellow sandstone or building stone, some of this being well rolled and waterworn, likewise gypsum, barytes, iron ore, and pyrites. Scattered about with the above, either in clayey beds or rough sand or gravel, there were some rounded and elliptically rolled lumps of indurated clayey conglomerate, containing small pebbles and shells, the latter chiefly in fragments.

From Newbold Astbury, near Mow Cop, ten miles south-west, carboniferous limestone, with some of its peculiar local fossils, besides limestone shale.

From Congleton Edge, nine miles south, specimens of the first and third grits, which are iron stained in a particular manner not noticeable elsewhere. Coming from a greater distance, probably from the

Welsh borders or Cumberland, specimens of the Silurian grits and sandstones, a few of them bearing fossil shells, and, with these, I include two or three rounded lumps of what appears to be an impure graphite.

There is no upper boulder clay in the Cemetery ground, but small and shallow breadths of it appear at intervals along a course of two or three miles to the west, and, at this point, the drift deposits reach their maximum thickness, which will be about 300 feet, and this is at an elevation of about 600 feet above the level of the sea.

I also exhibit the cast of a net sinker. The original, which I have presented to the British Museum, is made of burnt clay, and is probably of very early English date. It was discovered a few feet below the surface, in the lower part of the valley.

The fulgurite, which I have brought for your inspection, was got out of a bed of fine dry sand on the south side of Macclesfield, about three years ago; it was traced in a straight direction to a depth of 22 feet. This was a work of some difficulty, owing to its brittleness, and only short lengths of it were at intervals secured. Towards the surface its diameter had been about three quarters of an inch, and it tapered gradually throughout its course to about three or four feet from its termination, when it took a slanting direction, and then assumed the form of several filaments, which eventually became dispersed and obliterated in a soft spongy clay.

The proceedings then closed with the customary vote of thanks to the President.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 7.] VOL. V. [Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday afternoon, April 25th, 1865.

ANDREW KNOWLES, ESQ., President, in the Chair.

Mr. Plant laid upon the table for the inspection of members a piece of rock, which he said came from Cartmel, Lancashire. He had never seen one like it before. There was also a rock of a different character there which contained an impression of *Fucoids*.

Mr. Binney said the specimen was common enough at Blackpool, and along the coast north of that town. It was not a permian conglomerate, although that rock occurred at Roughtam Point, but merely a piece of dark shingle cemented together with carbonate of lime. The specimen of sandstone was a piece of the millstone grit commonly found near Holker, and the impression upon it appeared not to be a *Fucoid*, but to belong to *Crassopodia*, similar to one described by Mr. Tate, of Alnwick, and often found in the lower parts of that rock.

The following paper was read:—

ON WIRE ROPES.

By G. C. Greenwell, F.G.S.

In most of the colliery districts both in Great Britain and on the continent Wire Ropes are used for lowering into and raising from the mines the workpeople employed therein, as well as for bringing the coal to the surface. This description of rope, which had already been in use on the continent, was introduced into this country about 25 years ago, and, although like every thing new it was at first looked upon with great distrust, it has, like every thing good, eventually obtained general approval and use. The immediate predecessor of the wire rope for colliery winding was the flat hemp rope, consisting sometimes of four and sometimes of six ropes laid side by side and stitched together: and this form of hemp rope was the successor of the round hemp rope, used, within the memory of the writer, to draw coals in the north of England.

The flat hemp rope was first introduced to put an end to the whirling about of the load which resulted from the use of the round rope, before the era of guides or conductors in shafts; and after this last great improvement in mining economy, the flat rope was retained on account of the advantage which the comparatively small diameter of the first coil, and the increasing diameter as the load ascended the shaft, was found to afford to the winding engine.

The first form of wire rope used in collieries for winding up shafts was flat, in order in some degree I suppose to retain the advantage to the winding engine above referred to, and also probably as far as possible to enable the same rope drums to be retained without alteration. The thinness however of the flat wire as compared with the flat hemp rope diminished materially the advantage to the engine gained by the alteration in diameter of the rope roll as the rope coiled on or off. Another reason for the application of flat ropes might also be traced to the general nearness of the winding engines to the shafts. Be this as it may, it was, as nearly as I can now

recollect, seven or eight years after the introduction of wire ropes* that round wire ropes were used in winding shafts, and even yet some mining engineers are found to give the preference to flat.

For a reason already given, namely, the nearness of the winding engine to the shaft, there are many cases where round wire ropes are almost inapplicable. While on this subject I may, however, say that I have in some cases, where the engine is near to the pit, arranged for the round rope to coil upon itself, in one case with somewhat heavy loads and quick winding: in this case the cage with two tubs of coal weighed about 50 cwt., the rope weighed 14lbs. to the fathom, and the depth of the pit was about 170 fathoms; the drum was 13½ feet in diameter, the engine had two 26 in. horizontal cylinders, first motion. In those cases where this coiling on is practised it might naturally be expected that, as the rope coiled against the plate or shillboard of the drum, it would grip between the last coil and the plate, and so soon exhibit fraying or grinding at this place. Such however is not the fact in my experience. I have found that ropes treated in this manner always did their fair amount of duty.

Many years ago the writer saw a spiral drum, in the old round hemp rope times; and now there is partially introduced an extension of this plan, applicable to round wire ropes, the object being to give to round ropes certain flat rope advantages. Theoretically the idea is undoubtedly right; the practical value of the result will be a simple matter of pounds, shillings, and pence.

I shall now give a few instances comparative of the costs of flat and round wire ropes, and I give these from instances under my knowledge, where the near approximation in the depths of pits, and periods of observation gives a fair basis for comparison.

* I think among the first round wire ropes used for winding was one at Marley Hill Colliery, Durham, in 1847.

1.—Depth of Shaft, 73 fathoms.
Flat Wire Rope, 18 lbs to the fathom.
Coal lifted, 17 cwt.
Price of Rope, 70/- per cwt.
Cost per Ton of Coal, /0·211

2.—Depth of Shaft, and weight lifted same as last.
Flat Wire Rope, 20 lbs. per fathom.
Price of Rope, 70/- per cwt.
Cost per Ton of Coal, /0·252.

3.—Shaft and weight as above.
Round Wire Rope, 15 lbs. per fathom.
Price of Rope, 56/- per cwt.
Cost per Ton of Coal, /0·083.

4.—Depth of Shaft, 80 fathoms.
Round Wire Rope, 8 lbs. per fathom.
Coal Lifted, 6 cwt.
Price of Rope, 56/- per cwt.
Cost per Ton of Coal, /0·143.

5.—Depth of Shaft, 90 fathoms.
Round Wire Rope, 15 lbs. to fathom.
Coal lifted, 17 cwt.
Price of Rope 56/- per cwt.
Cost per Ton of Coal, /0·099.

The average of the above gives as the cost per ton of coal, for flat wire ropes /0·231, and for round /0·108. It will be observed that since the above data were obtained a large reduction has been made in the price of wire ropes; assuming (what I have no reason to question) that the quality and durability of the ropes are equal to what they were at that time, the cost per ton of coal would be reduced to /0·158 for flat, and /0·069 for round ropes for such depths as above.

I shall now proceed to make a few observations upon the working loads of pit ropes, a subject in my opinion deserving of a much greater amount of attention than it has hitherto received, and the more especially when we take into consideration the already great

and continually increasing depth of our coal shafts. The usual calculation for the adaptation of the size of a wire rope to a given working load is to divide the weight in cwts. at the pulley, when the full cage is leaving the pit bottom, by 4 in the case of flat, and by 5 in the case of round ropes, the quotient in each case giving the size of the rope in pounds weight per fathom. Thus, suppose the depth of a pit from the pulley to the bottom to be 100 fathoms, the weight of the cage and full tubs 50 cwt., x the weight of round rope in lbs. per fathom.

$$x = \frac{\frac{100x}{112} + 50}{5} = 12{\cdot}18 \text{ lbs. per fm.}$$

The reason for making this difference between flat and round ropes is obvious, and I rather feel inclined to doubt if sufficient difference is made. There is in the first place allowance to be made for the weight of wire used in the stitching, which is no contributor to the strength of the rope, but the reverse, being of itself so much dead weight thrown upon the strands; and in the second, what is of still more consequence, there is the great difficulty to be surmounted of getting the strain exactly and equally distributed over each of the ropes sewed together. I have known instances of flat wire ropes breaking very unaccountably when almost new, and am much inclined to attribute this to the cause last named. There is, however, an element in the calculation of the strength of ropes which does not seem to have been taken into account, but which I think is of sufficient importance to deserve mention in this paper.

We will suppose a case in which the working load has been required to be drawn up the shaft at double its former speed, and that, for the purpose, an engine of the necessary increased power has been applied; we have here the working load the same as before, and therefore, in accordance with present practice, we would make no alteration in our ropes, forgetting apparently that whereas we formerly had say 50 horses tugging at them, we now perhaps have 150. Under ordinary circumstances, *when the cage in the shaft*

has attained its full speed, there is probably only the additional friction added to the strain on the rope when the speed is high as compared with when it is low; but from the lift up to the time when the maximum speed is attained (which is precisely when almost all wire ropes break), there is of course a far greater strain put upon the rope by the increase in the size of the engine. Also in case of any irregularity in the guides whereby the cage is impeded, the whole additional power of the engine is brought to bear upon the rope.

I am not prepared to give an opinion as to the exact degree in which this element should be considered, but having introduced it, it may perhaps by rope makers be thought worth attention. If we could rely upon perfect uniformity in the composition of the wire of which ropes are made, my impression is that they might with advantage be used considerably lighter than they are; and that it is to the great margin that exists between the breaking strain and the working load we are to attribute the want of a more scientific adjustment of the rope to the load.

From much observation of the performances of wire ropes at different collieries, I am under a very strong belief that time rather than strain is the great enemy they have to contend with; and I think the experience of others will bear out the fact that any wire rope will, during its service, wind a very much larger quantity if the daily quantity is large than if it is small. From one to two years may (with a few exceptions) be taken as the term of duration of pit ropes, whether they draw 400 tons per rope per day, or whether they draw only 100.

Is this deterioration produced by time to be attributed to rusting of the wire? or to a crystallization, produced by its motion over the pulley and drum? or to some natural tendency, not yet accounted for, of iron to become crystalline? If produced by the first process, it is clear that a careful oiling of the rope will, to a certain extent,

prove a remedy. If, by the second, the durability of the rope would be proportioned to the amount of work performed, which is not the case. The third process is, I think, the principal cause of deterioration, although it may very possibly be aided by the other two, for I have frequently observed that the wire of an old rope has lost much of its flexibility and toughness, and become comparatively brittle. As bearing upon this point it would be very interesting to know if this tendency to crystallization exhibits itself in wire ropes not subjected to motion, such as for instance are used in suspension bridges.

If, as has been already stated, it is correct to estimate 5 cwt. as the working load of a wire rope weighing 1 lb. per fathom, it is clear that to the end of 5 cwt. of such a rope no working load can be safely appended; and the length of such a rope would be 560 fathoms, and the same holds true of any size of rope. From this we arrive at the following result, viz.: that the working load of any rope is the weight of the difference between its length and 560 fathoms; for instance, that the working load at the depth of 100 fathoms would be 460 times the weight of the rope in lbs. per fathom. We have ropes working in shafts 300 fathoms in depth; and supposing such ropes to weigh 15 lbs. to the fathom, the working load should not exceed $260 \times 15 = 3900$ lbs., or 35 cwt. This points very forcibly to the substitution, at great depths, of steel for iron wire ropes; and to the growing necessity there thus becomes for great attention to the production of a steel wire rope of more reliable character than that yet manufactured.

I have not much experience in steel wire ropes; the only important one which I have used was employed in working an underground engine bank, by means of an engine at the surface: in this case the depth of the pit was 240 fathoms, the plane was 400 yards long, dipping other 90 fathoms from the shaft down to the face. This rope was however quite satisfactory, and if one rope can be made good, no doubt equal care would make all equally so. For

pits, the depth of which exceeds 150 fathoms, the ropes on the continent are tapered. The want of elasticity of wire ropes renders ample power in the machinery absolutely necessary; for when the engine is weak in proportion to the load to be raised, it—particularly in the case of single cylindered engines—is impossible without starting the engine quickly to get over the centre; this therefore points to the superiority of double cylindered engines for wire ropes. Many attempts have been made to apply springs to wire ropes, but most of them hitherto have been unsuccessful. The volute steel, and the Indian rubber spring have both been applied to the end of the rope next to the cage, but they only are of use as regards the load itself at the start. A spring to be of real use should have its influence not only over the mere cage and coals, but over every thing lifted or strained by the engine from the drum to the bottom of the pit. This requirement is beautifully fulfilled at the Chauffeur Pit of the Compagnie d' Anzin, near Valenciennes, the depth of which is 350 fathoms, by an arrangement which I went up to the pulleys to examine. The pulleys there are suspended from inverted coach springs which give a considerable amount of vertical play; but the utmost required seemed to be about six inches; this of course is equal to twelve inches upon the rope, and is, as before stated to be requisite, equally distributed over the whole length of the rope; upon this spring, every stroke of the engine was observable.

It seems preferable in all cases to have rope drums covered with wood, bolted to the planes, care being in all cases taken to have the bolt heads sufficiently counter sunk; and as it is of the utmost consequence that the pulleys should be perfectly smooth and round, they should be turned up in a lathe. The greatest care should also be taken that the pulley is set perfectly true. If there are twelve turns of the rope when coiled on the drum, the centre of the pulley should be at right angles to the first turn, but the plane of the pulley should point to the middle of the coil, say between the sixth and seventh turn; and care should be taken that the U of the

pulley should be so wide as to allow the rope when at either end of the coil free entrance and exit. If the circumference of the pulley were made of wood, it would no doubt be of advantage to the rope.

With one remark I may close this paper. There have, I think, come under my notice, practically, wire ropes of all kinds and sizes, made by most of the manufacturers, and to their credit be it spoken, I have never yet discovered the employment of a spurious or low class material in the construction of these ropes. As mines are increasing in depth, I would counsel them to endeavour, if possible, to increase the value of their manufacture by improving its strength in a greater ratio than its weight, whether by the substitution of steel for iron wire or of tapering for uniform ropes, or by the combination of both, I leave them to determine.

The thanks of the Society were given to Mr. Greenwell for his paper.

Mr. Chattwood said he thought, referring to a question raised on the subject in the paper, that iron did not crystallize when in suspension unless there was motion.

Mr. Binney said it had been disputed by many people whether wrought iron did become crystalline. In using iron wires there would always be difficulty and even danger in the "set" of the rope, especially when the drums were small.

Mr. Baldwin said the set ought to be taken into consideration when the ropes were manufactured. These wire ropes no doubt to a large extent must loose their elasticity.

Mr. Farrimond said a wire rope would last double the time overlapped than underlapped.

The President in answer to a question said that, a rope when the

breaking strain would be 15 tons would be worked to the extent of 30 cwt.

Mr. Baldwin said that 90,000 lbs. of tension were given to the square inch for iron wire, nearly double what was allowed for iron bar.

Mr. Binney said if all the iron in the strands of the rope was not of the same quality, there would be an effect produced similar to that of an electric battery. He had seen a battery produced by the late Mr. Sturgeon, from two pieces of iron of different quality.

Mr. Greenwell, in answer to a question from Mr. Horsfall, said a failure in a wire rope could be detected as soon at least as in a hemp rope. If statistics were collected, as many accidents would be found to result from the use of hemp ropes as from the use of iron ropes.

The President said hemp ropes would not be found to answer under the circumstances of the present day. One great advantage in using wire ropes was that they increased the possibility of mines being worked, where otherwise no work could have gone on. It was once thought very generally that at a certain depth hemp ropes would break with their own weight. By the help of iron or steel ropes no doubt some day mines would be worked thousands of yards deep, provided they could be made to pay.

This closed the discussion, and the meeting broke up with the usual vote of thanks to the President.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 8.] VOL. V. [Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday afternoon, May 30th, 1865.

MR. W. R. BARR, in the absence of the President, in the Chair.

Mr. Dickinson read the following paper by Mons. Breguet:—

DUMAS' LAMP,
FOR THE USE OF MINES.

The apparatus called "Dumas' Lamp," utilises the light produced in a vacuum by the passage of currents of induction; it consists then in a necessary manner, of a battery, an *Induction apparatus*, and a *vacuum-tube*, called a Geissler tube, from the German Manufacturer who made the first.

The battery furnishes a quantity current; this inducing current produces in the induction apparatus an induced current or one of tension; and finally this induced current, traversing the vacuum tube, produces there a light sufficient for conducting one in darkness, for reading characters traced on paper, or even divisions engraved on an instrument, finally for working in a mine.

Of the Battery.

The battery is of two liquids; in the interior of the porous cell is a piece of carbon, which forms the positive pole of the battery, and which is immersed in water, acidulated with sulphuric acid, marking 16° on the hydrometer (for acids), to which is added pulverised red bi-chromate of potash. At the exterior of the porous cell is a cylinder of amalgamated zinc, forming the negative electrode of the battery, immersed in a solution of sulphuric acid to 6° of the hydrometer. The cylinder of zinc has a diameter but little different from the porous cell, so that the distance between the electrodes should be as little as possible, and consequently that the resistance is as small as possible. The exterior case of the battery is a bag of india rubber, at the bottom of which is placed a round piece of amalgamated zinc, which increases the surface of the negative electrode, and serves as well to support the india rubber bag, as to protect the porous cell against any shock or shake.

The upper part of the battery is closed in a manner completely *hermetic* by a plate of hardened india-rubber, kept in its place by screws. Two small tubes of india-rubber, communicating one with the interior and the other with the exterior of the porous cell, give exit to the gases which are formed by the working of the battery.

The battery thus composed can give a constant light during 12 hours at the least; but if it is not kept at work, it is preserved much longer, and can give light at the end of a week.

The expense of maintenance of this battery may be valued at one cent. per hour of effective working, or 1d. for a day of 10 hours; and this expense being the only one which the use of the Dumas Lamp requires, it is seen that this apparatus costs less than a Davy Lamp.

Of the Inductive Apparatus.

The inductive apparatus does not differ essentially from apparatus of this sort employed in laboratories.

Around a centre composed of iron wires, well annealed, are wound two layers of a primary wire, called the "inductor" of a sufficiently large diameter, through which passes the battery current. Around this "inductor" is wound the induced wire, of which the diameter is much less, and of which the spires and the different layers are insulated one from the other with the greatest care. The induction circuit is provided with an automatic trembler, which interrupts the induction current, and re-establishes it with great rapidity.

The two extremities of the induction wire are placed in communication with the two metallic faces of a Fizeau condenser, the action of which, upon the luminous effects of the induction apparatus is very important. To each of the making or breaking of the induction current, corresponds an induced current of the fine wire of the coil, and sent into the luminous tube.

Of the Luminous Tube.

The luminous tube is a tube of glass in which a vacuum has been made after having filled it with azote or nitrogen, so that it still contains very rarefied azote. This tube is sealed to the lamp, so that it preserves its vacuum indefinitely. It shows a central chamber in which are placed two rather fine tubes, one of which has circumvolutions spread out in the same plane, which have the effect of multiplying the lighting surface, and of consequently augmenting the light.

These fine tubes are made of glass or uranium, whose fluorescent properties render more constant the light from the current of induction, which, in fact, is intermittent, although it is impossible for the eye to distinguish the intermittence. This vacuum tube, which, already is of a sufficiently great thickness, is protected by a very thick exterior tube, the solidity of which is very great. The exterior tube can be surrounded with a special reflector, half cylindrical, which throws the light forward that would otherwise be lost.

ACCESSORY PARTS AND GENERAL DISPOSITION.

A turning commutator placed above the battery, allows one to close or open the induction circuit, and consequently to make the light appear or disappear. The battery and induction apparatus are enclosed in a box of leather and in wood, furnished with a cover, closed with screws with hardened india-rubber nuts. The commutator alone projects a nut or button in hardened india-rubber, above the before-mentioned cover.

The box is supplied with a leather band, which enables the apparatus to be carried in a shoulder belt. The tube is attached to this box by conductors, 75 centimetres in length, carefully insulated with cotters, first a tube of india-rubber, then a second tube of india-rubber sufficiently thick, which gives a great resistance, and a certain thickness to these cords. By aid of these conductors, the tube held in the hand can be passed by the bearer all round him, whilst the box which furnishes the current rests immovable on his back, or on any support whatever.

For facility of transport the tube has also a place made on the side of the box, in which it is sustained by leather bands, of such a sort that even in this position it can lighten the path of the person who carries the instrument, especially if he is supplied with the reflector of which we have spoken. In the box itself the wires which place in communication the battery and the induction apparatus, are insulated with the same care as the external conductors, terminating in the luminous tube; finally the induction apparatus enclosed in a small wooden box is placed in a double envelope of sufficiently thick india-rubber.

All these envelopes have the accessory advantage of decreasing the shocks the apparatus might receive; but their principal object is to prevent an electric spark from passing between the conductors, and firing the explosive mixture of gas in which the apparatus might be placed, which would produce the greatest danger. Every

body who sees the Dumas Lamp perceives at first sight that this danger is completely averted.

Advantages of the Lamp.

It is known that in mines it frequently happens that the gases which escape from the sides, form, with the air, explosive mixtures. The introduction of an ordinary light in a mine where these phenomena are produced might cause the most frightful accidents, in producing the explosion of the gaseous mixtures of which we have just spoken. It is under these circumstances that the use of safety-lamps becomes necessary.

Amongst the most used, and most useful of the safety-lamps, is that of Davy, which might be taken as a type. The Davy Lamp has several great defects; first, it may be opened by the workman who carries it, and who when wishing to obtain a more brilliant light, would let it burn without the surrounding protection of metallic net; it might be extinguished, if, as is often the case, water should fall upon it from the roof of the gallery; placed in an impure atmosphere it fails and sometimes suddenly goes out, leaving the workmen without light. Moreover, in cases where light is necessary in order to prevent danger, it may happen that one has men to save, urgent works to execute in an atmosphere where life is possible at least for a short time, and where the Davy Lamp cannot burn. In such cases the Dumas Lamp would be of an inappreciable value; for it burns as well in a gas, absolutely unfit for combustion and for respiration; under water, and in all the conditions where ordinary combustion lamps are either dangerous or unable to give light.

It will be remarked that there is no possibility of explosion of inflammatory gases from the spark of induction, for it only passes in vacuum (at least from the distance where the two platinum points are placed, which are sealed at the two ends of the vacuum tube); and if by accident the vacuum tube should be broken, the air would

enter the vacuum, and immediately all light and all passage of electricity would cease.

Accessory uses of the Lamp.

It is known that electric currents have been used for a long time to explode powder and to blast mines. Such has been up to this time the only industrial application of the induction apparatus. The Dumas Lamp offers two means of arriving at this result. The first consists in employing the intermediary of the induction apparatus; one has only to suppress the communication between the induced wire and the luminous tube, and to attach it to the insulated metallic conductors which are attached to a Stateham or Abel fuse, in which two metallic points, placed at a short distance from each other, and surrounded with sulphuret of copper, and of a small quantity of fulminate of mercury, then ordinary powder, letting escape the spark of induction and lighting the powder.

The second means employs directly the battery; it is sufficient to send the current of the battery in a fuse specially composed as follows:—a very small platinum wire, attached to the ends of two wires which come from the battery; this platinum wire is surrounded with gun-cotton first and ordinary gunpowder afterwards, enclosed and held in a small gutta percha bag. When the current passes this, the platinum wire reddens and ignites the gun-cotton, which sets fire to the gunpowder used in the mine. This second means, is, according to M. Dumas, the surest and most convenient.

A cordial vote of thanks was passed to the author for his contribution.

The Secretary, read a letter from Mr. Binney who regretted that he was not able to be present at the discussion of so important a subject as a new mining lamp. He had read M. Dumas' paper, and he begged to thank the author for his labours, which would be duly appreciated by all scientific men. Every man who endeavoured to diminish the occurrence of explosions in coal mines was entitled to our warmest thanks. Many attempts had been made to introduce the electric light in close vessels for the illuminating of coal mines; but although the theories propounded were doubtless true in the abstract, it had not been possible to make an electric light fit for practical use by a common collier. This remained to be done. Speaking for himself, he did not think that a workman in a mine could have a much more safe light than that afforded by Stephenson's, or any other lamp which went out when it was taken into an explosive atmosphere. Where there was gas in a mine it ought to be swept out as soon as possible. No delay or tampering with it ought on any account to be allowed, either with the use of so called safety-lamps or any other means. Everybody now admitted that good ventilation, properly applied was the first thing. Mixed lights, namely, the use of lamps and candles in different parts of the mine at the same time, were all but universally condemned, and ought never to be sanctioned. Wherever gas had been found in a mine, that mine ought to be worked with lamps so as to be prepared for its re-occurrence. This was also now generally admitted.

With the above named three fundamental precautions being constantly observed, there would be very few explosions of fire-damp in coal mines. We have now the means of preventing in a great measure these terrible catastrophes in our collieries if we properly applied them. What we wanted was not so much new contrivances as the constant use of those means we were now possessed of. Any light which should be introduced as a substitute for ventilation, would be a great curse; and when that light was enclosed in a glass, liable to all the rough usage of a coal mine, it would be

dangerous to employ it and trust to it. A great deal had lately been said about having an improved instrument for indicating the presence of fire-damp in a mine, and much ingenuity had been shewn in producing such a thing. Did not the light of a Davy Lamp, with its cap of flame, show the presence of fire-damp sufficiently to set about improving the ventilation of the mine, having first removed the men out of it? He thought it did. No common miner ought to be allowed to work or continue in an explosive atmosphere, either with lamps or enclosed electric lights; and any contrivance of an apparatus, however ingeniously derived, which would tend to sanction that practice, was, to say the least, very dangerous, and much to be condemned. Every one knew that a coal mine was quite a different place from a laboratory, and what was all very well for the latter was quite out of character, as a practical thing, in the former.

Mr. Greenwell said that the author of the remarks just read, talked of the inadmissibility of any light unprotected by wire gauze for fear of fracture. But with this electric light that danger was removed, because the light went out when a fracture occurred. It was perfectly clear that even if this lamp was capable of being burnt in a mixture in which human life could not exist, no person could take the lamp there to assist men who were in need of help. But so far as giving assistance to people who might be injured from other causes than after-damp, and where the fire-damp might render it very dangerous for other lamps to be taken in, no doubt this electric light might be of great use.

Mr. Aitken said that if the lamp was too cumbersome to be carried by the miner, it would not be of much practical use.

Mr. Clegg Livesey, in answer to one or two questions, said Mons. Breguet had informed him that he had no expectation of bringing his lamp into general use in its present large form. It was as large as a man's hat. He thought it very advisable that every

colliery should have one lamp in reserve in cases of accidents. The price was about £10. The lamp was being extensively used in France and Belgium, where they were kept in mines to use, if required, on special occasions. The whole apparatus was kept in one box. Mons. Breguet was one of the best electricians in France, and the inventor of the electric bells.

Mr. Dickinson said he had seen the lamp, and it could not be denied that at present it was a very cumbersome affair, and might not be of very great practical application just now, as our own Davy, Mueseler Clanny, or Stephenson lamp. The light itself would be by no means equal to the Davy : one could grope one's way with it, but it would be no advance upon the existing contrivances ; still it contained the elements of something which might be made of valuable service.

Testing for Fire Damp.

Mr. Dickinson said he wished to give the meeting a short account of some experiments made by Mr. Ansell, of London, in testing for fire-damp. Some years ago it was discovered by Mons. Döbereiner, by the escape of hydrogen gas from a crack in a jar standing over water, that diffusion of gas was taking place. This was looked upon as a phenomenon somewhat akin to single diffusion, and the passage of gas in one direction only. The subject had recently been taken up, and the law upon it worked out by Mr. T. Graham, F.R.S., who in 1863 read a paper at the Royal, Society on the Molecular Mobility of Gases. The subject was an exceedingly interesting one, but it required some time to be known thoroughly. He (Mr. Dickinson), if the Society wished, would run over a few heads of Mr. Graham's paper in order to show the foundation upon which the law was proposed to be carried out by Mr. Ansell, whose proposition was to apply it for the indication of fire-damp, coal gas, and choke damp, in mines, ships, &c. The following were extracts from Mr. Graham's, paper :—*See Trans. June* 18, 1863, *p.p.* 385, 389, *and* 404-5.

A sketch of the Diffusiometer, by which Mr. Ansell proposes to effect his purpose, was then shewn and explained, and in conclusion Mr. Dickinson said that Mr. Ansell had full faith in the instrument. A rough model had answered, and if Mr. Ansell could but carry out the principle he proposed, it might become a valuable addition to the present means of testing the gases.

The thanks of the Society were voted to Mr. Ansell for his communication.

A conversation then took place, during which Mr. Dickinson said that he could not go so far as to say that, in its present state, the instrument was of any practical use to coal-miners, because the safety-lamp already in use was one of the most perfect means of indicating the presence of gas.

Two or three members were of opinion that the apparatus might probably be made to work at the bottom of the mines, but to indicate the result on the top.

The meeting closed with the usual vote of thanks to the Chairman.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 9.] VOL. V. [Session 1864-65.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday afternoon, June 27th, 1865.

ANDREW KNOWLES, ESQ., President, in the Chair.

Mr. Plant presented for the Society's Museum eight specimens of the newly discovered Trilobite, *Paradoxides Davidis*, from Tyddyngwladis, North Wales,—full descriptions of the discovery, together with a diagnosis and figures of the Trilobite, have been published in the Quart. Jourl. Geo. Soc., London, for 1863-4, in the Decades of the Geo. Survey, No. XI; and in the Transactions of the Geo. Soc., Manchester, Vol. V.

Mr. Dickinson said it was important to remember that these specimens were taken from the very lowest beds, not from what were called the Silurian, but from what were called the Cambrian. In examining the North Wales district, he himself had always thought that the line of division laid down between the Silurian and Cambrian was a very artificial one. It was in some respects unfortunate that there should be a line attempted where there really was no division; he had always regretted that the old name of metamorphic had not been retained. The fact that the specimens

brought by Mr. Plant came from the very bottom of these formations proved that there was no marked division.

Mr. Plant said he quite agreed with Mr. Dickinson that the division between the Cambrians and the Lower Silurians was an arbitrary one, and the discovery of these fossils was evidence that the division must be given up. It was the most interesting discovery palæontologically considered, that had been made in England for some years, because it showed that in this, the lowest zone of the Silurian, fossils of gigantic size existed in enormous numbers.

The thanks of the Society were voted to Mr. Plant for his gift.

Mr. Wild presented a couple of fine specimens of *Calamite* taken from the middle of the coal-measures in the Blendfire rock, and received the thanks of the Society for his contributions.

The following paper was then read :—

PIT HEAD FRAMES:

BY

J. J. HORSFALL.

My object in reading a paper on the above subject is to give to the members of the Society the result of my own experience in the erection of "pit head frames." I understand that there has been no paper read on the subject before this Society, and my remarks will refer only to common frames, not being connected with any coal screens, or where any extraordinary length is necessary; but as the subject is of the greatest possible importance to Mining Engineers, and others connected with collieries, I hope that if no

other purpose is answered, members who have had more experience than I have had, will give us the result of it, which will be conferring a boon on many.

In every colliery district we find different arrangements, and scarcely do we find two precisely alike. When we come to examine some we find that there is a great deal more timber connected with them than what is absolutely necessary, whilst on the other hand we find others that totter and tremble under their work to that extent, that to the eye of a stranger they appear as though every load would raze them to the ground. I am of opinion that the laying out and erection of "pit head frames" require a great amount of skill and judgment in order to render them as economical and safe as possible.

The first important question with regard to this subject is, what kind of timber is best adapted to the purpose? I have made frames of two kinds, viz. :—pitch-pine and memel-pine, and as yet I have been unable to perceive any difference between the two so far as the performance of work is concerned, although many engineers prefer the former. If the latter be procured clear from "knots" and "cracks," my impression is, that it will answer the purpose equally as well as pitch-pine.

Another important point to be considered is the strength. This must of course be governed by the amount of work to be done, but I think the following formula will be of great service in determining this question.

The crushing force of American-pine is 5430 lbs. per square inch, and the maximum load which can be safely put vertically upon each square inch of section is 1357 lbs., being the quotient of dividing the crushing weight by 4. Consequently, if we take as an example a "pit head frame," the top of the uprights (which will be the least) being 11 inches square, we find that the maximum load

which can be put vertically upon these uprights will be 146½ tons. But, since in making these frames the uprights are not vertical, we do not expect that they will resist anything approaching the weight named, and it is also most probable that the formula given has been obtained from *short pieces* of very sound timber, consequently in practice the resisting force would not be so high from the fact before stated, that the pressure is not applied exactly vertical, and the consequent tendency of the pressure to force the timber from a straight line to a curved form. We must of course make all necessary allowance for this.

The strongest frame that I have made is 13 inches square at the bottom of the legs and spurs, and 11 inches square at the top, and the weight constantly working on this frame is 5 tons, which will very shortly be increased to double that amount. The height of the frame from the sill to the centre of pulley is 36 feet.

After procuring good, clear, and sound timber, the next important business is the manner in which the whole are jointed and put together; and this is a very important matter, for however good the timber may be, unless the workmanship be good, the whole will be a failure. In one case I had only *single* tenon joints, but in all the others I have had double tenons, and passing through each tenon there is a strong bolt as in No. 2 plan. In No. 1 plan the tenons are single, and you will perceive there is a wrought iron strap all round the leg at each joint, and carried forward along the sill for a considerable distance. In the other case, however, I have only a simple piece of iron to act as a washer for the bolts. At the bottom and top of the spurs I have put cast iron sockets, and also at the foot of the uprights, in plan No. 2; but in plan No. 1 you will perceive that instead of having "*sockets*" at the top, there is a strong wrought iron plate, secured on each side of the frame by bolts. After the joints are well fitted I have them well covered with red lead.

I confess that I consider it unwise to have the "spurs" connected in any way with the engine-house or any other building, but think that it is necessary to have them detached and to be independent of any fixture in the shape of buildings. There is not that liability to settle unevenly when laid on sills which run from the uprights to the spurs; still in one case I had blocks of stone under each "leg" and "spur," yet, I found in course of time that one part of the frame had settled, and I experienced the greatest difficulty in getting the whole frame put square. If laid on *wooden sills*, the whole or any part can be lowered or raised with ease.

In providing pulleys it is especially necessary that the size and shape should be taken into consideration. Whenever flat ropes are used, the face of the pulley ought to be perfectly flat. We generally find that the face of the pulley is made rather circular, in order to compel the rope to travel in the centre of it. This system cannot be too strongly condemned, as it has a tendency to damage the rope by the continual tearing strain to which it is subjected. The size of pulley for wire ropes should not be less than 12 feet diameter, but if hemp ropes are used a less diameter will suffice, and it may be reduced to 8 feet.

The best, and undoubtedly the most economical kind of pulley is the one with cast iron boss and rim, and wrought iron arms. They can be procured at a cheaper rate than the old fashioned cast-iron pulley.

In coating pit head frames I have in some cases used red lead, whilst in others I have used a composition of tar and turpentine. I have also used common gas tar, and foreign tar. The composition is as follows:—

Common Gas Tar	10 gallons.
Turpentine	2 ,,

If foreign tar is used it is not necessary to put turpentine with it, but take 12 gallons of it alone. Either of these should be put on

the timber whilst in a hot state, and it is very necessary to have the timber as dry as possible. A man will, under ordinary circumstances, apply four coats of composition to a pit head frame in one day's time, after which, the whole will have a bright glossy appearance, and to all appearance capable of preserving the timber, and iron, much longer than red lead.

The following is the cost of a pit head frame, including all workmanship and material, erected according to No. 1 plan, taking it to be 36 feet high :—viz.

Timber	£44	4	10
Pulleys and Pedestals	49	0	0
Wrought Iron	20	13	4
Cast Iron	2	3	1½
Wages, including making, erecting, &c.	14	0	0
Total	£130	1	3½

The cost according to No. 2 plan is :—

Timber	£44	4	10
Pulleys and Pedestals	49	0	0
Wrought Iron	7	12	0
Cast Iron	3	0	0
Wages, &c.	12	0	0
	£115	16	10

Thus there is a balance of £14 4s. 5½d. in favour of No. 2 plan, which plan I consider to be equally as strong and durable as No. 1.

As I have before stated the above is the result of my own experience, and I hope that some other member will take up the subject, as it is of such vital importance to Mining Engineers.

The thanks of the Society were given to Mr. Horsfall, and it was resolved to publish the diagrams in the transactions.

MARCH 12TH 1861

MARCH 12 1861

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 10.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Thursday, October 26th, 1865.

E. W. BINNEY, ESQ., F.R.S., F.G.S., Vice-President, in the Chair.

The Chairman, in his opening remarks, said he was sorry they had so small an attendance of members, but the day was not one of the most convenient for country gentlemen to attend, and he supposed that the meetings had been held so often on a Tuesday, when the town gentlemen could not attend, that the latter had forgotten all about it. However, the business was merely of a routine character,—to receive the reports of the Council during the past year, and then to appoint officers for the ensuing year. He would now call upon the Secretary to read the reports.

Mr. J. E. Forbes, F.G.S., one of the Honorary Secretaries, then read the reports, and also the Treasurer's statement.

HONORARY CURATORS' REPORT.

The Honorary Curators reported receipt of the following donations during the past session:—

FOSSILS, &c.

PRESENTED BY MR. JOHN WILD—
Specimens of Calamites and Fossil Wood, from the Blendfire Rock.

PRESENTED BY MR. T. A. READWIN AND MR. JOHN PLANT—
Specimens of Paradoxides Davidis, from North Wales.

PRESENTED BY MR. G. C. GREENWELL—
Shells from near Cardiff, and Animal Remains from Nunney, Somersetshire.

PRESENTED BY MR. JOHN STEWART—
Carbonate of Lime, from Laxey Mines, Isle of Man.

BOOKS, &c.

PRESENTED BY COLONEL R. STRACHEY, R.E.—
Palæontology of Niti in the Northern Himalya.

PRESENTED BY S. V. WOOD, JUN., ESQ.—
Remarks on the Upper Tertiaries of Norfolk, &c.

PRESENTED BY THE COUNCILS, &c.—
Quarterly Journal of the Geological Society.
Proceedings of the Geologists' Association.
Transactions of the Liverpool Geological Society.
Transactions of the Dudley and Midland Geological Society and Field Club.
Transactions of the Glasgow Geological Society.
Transactions of the North of England Institute of Mining Engineers.
Annual Report of the Leeds Philosophical and Literary Society.
Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire.
Proceedings of the South Wales Institute of Mining Engineers.
Rules of Birmingham Field Naturalists' Society.
Report of Belfast Field Naturalists' Club.
American Journal of Science and Arts.
Mining and Smelting Magazine.
Annual Report of the Geological Survey of India, and of the Museum of Geology.—Calcutta, 1863-4.
Memoirs of the Geological Survey of India; Published by order of His Excellency the Governor General of India, under the direction of Thomas Oldham, L.L.D.—Vol. III., Pt. 2, and Vol. IV. Pt. 2.
Sitzungs-Berichte der Naturwissenschaftlichen, Gesellschaft Isis zu Dresden.—Redigirt von Dr. A. Drechsler Jahrgang, 1863.
Die Philosophie im Cyclus der Naturwissenschaften, Vorwort zur Eröffnung des Naturwissenschaftlichen Cyclus in Dresden, von Dr. Adolph Dreschler.

Report of the Council.

In surrendering the charge placed by you in their hands during the past year, your Council, according to the Society's rules, present to you a report of the year's proceedings; the Treasurer's account of receipts and disbursements; a list of donations to the Library and Museum of the Society; and a list of Papers read at the general meetings during the session.

Your Council have much pleasure in directing your attention to the improved financial position of the Society, the balance in the hands of the Treasurer having increased from £76 15s. 2d., where it stood at the end of the 1864 session, to £121 4s. 2d., but they feel themselves obliged to notice that some subscriptions are considerably in arrear, which, if paid, would materially improve the Society's position. They trust that this notice may produce an improvement in this respect. The list of donations to the Library and Museum of the Society is an unusually long one, and as bearing testimony to the public good feeling towards the Society, cannot but afford gratification to its members.

The Papers which have been read to the Society by its members during the session have been more numerous than has usually been the case: they have consisted of Papers on both geological and mining subjects; and your Council trust that they have in no degree lowered the standard of excellence which the proceedings of the Manchester Geological Society have attained in the estimation of the scientific public.

During the past year four new members have been added to the Society; four have resigned; and the loss of three by death, has to be regretted. These were—Sir Benjamin Heywood, Bart, Mr. Goodwin, and Mr. Martin Seymour. In the loss of Mr. Goodwin, a constant attendant at the meetings of the Society, and the contributor of several valuable Papers, the Society have to lament their deprivation of a most useful member, and cannot but feel sorrow

that one who by his exertion and talent had succeeded in raising himself to such a position, as would no doubt have resulted in a successful career, should have been carried off by death in the prime of his life and usefulness.

Your Council are sorry that they have no report to make of a Field Day during the session: they trust, however, that during the next year the Society will take an opportunity of arranging a few geological excursions, believing, as they do, that geological precepts are of little avail when not accompanied and borne out by geological practice, and that geologists are none the worse for occasionally a little social attrition and glaciation themselves.

List of Papers Read, Session 1864-5.

Account of the Society's Excursion to Llangollen.—By Mr. J. E. Forbes.

On the South Eastern portion of the Somersetshire Coal Field.—By Mr. G. C. Greenwell,—(with Map and Sections.)

On the Pliocene and Post-Pliocene Deposits in the Neighbourhood of Norwich. —By Mr. John Taylor.

On Alluvial Deposits on Travis Isle, Collyhurst.—By Mr. John Plant.

Additional Notes on the Drift Deposits in Burnley, &c.—By Mr. T. T. Wilkinson.

On the Discovery of Parodoxides Davidis,—By Mr, J. Plant.—(with Plates and Map of District.)

Remarks on the Manufacture of Fossils at Macclesfield.—Mr. J. Plant.

On Certain Appearances of Glacial Action on Rock Surface near Clitheroe, and Chief Geological Features of that Locality.—Mr. J. Aitkin.

On the Outcrop of the Lower Coal Measure Rocks on Bouldsworth and Gorple. —Mr. J. Whittaker.

On the Macclesfield Drift Fossils.—Mr. R. D. Darbishire.

On the Macclesfield Drift Shells.—By Mr. Sainter.

On Wire Ropes.—Mr. G. C. Greenwell.

On M. Dumas' Lamp for the use of Mines.

Account of some Experiments made by Mr. Ansell in testing for Fire Damp.

On Pit Head Frames (with Diagrams).—By Mr. Horsfall.

MANCHESTER GEOLOGICAL SOCIETY.

BALANCE SHEET.—1865.

Abstract of Receipts.

1864.		£	s.	d.
To Balance brought down		76	15	2
„ Subscriptions, 1863-4, 9 0 0; 1864-5, 124 0 0		133	0	0
„ Composition		10	0	0
„ Interest from Bank		4	7	8
„ Dividends		6	16	9
	£230	19	7	

Abstract of Payments.

1864-5.	£	s.	d.
By Library	3	9	8
„ Reports of Meetings	59	7	0
„ Reporters	8	8	0
„ Printing and Stationery	6	18	3
„ Postages, Delivery of Proceedings, &c.	19	8	6
„ Collector's Commission	6	13	0
„ Insurance	0	6	0
„ Gratuity to Mr. Parker	5	5	0
	£109	15	5
„ Balance carried down	121	4	2
	£230	19	7

To Balance brought down £121 4 2

Examined and found correct,
24th October, 1865,
JAMES HERTZ.

HENRY M. ORMEROD, Treasurer,
10th October, 1865.

LIST OF NEW MEMBERS ELECTED IN THE SESSION 1864-5.

Mr. Thomas Whipp, Bowden. | Mr. Joseph Grimshaw, Stoneclough.
Mr. E. Ashworth, Waterfoot. | Mr. James Newell, Bury.

DECEASED.

Sir Benjamin Heywood, Bart. | Mr. Joseph Goodwin
Mr. Martin Seymour.

RESIGNED.

Mr. Matthew Bennett, Little Hulton.
Mr. Henry Bramhall, Rainford Colliery.
Mr. F. N. Fairbank, Hulme.
Mr. Richard Smith, Collyhurst.

The Chairman then said that as there were not many members present he should be obliged to resort to a custom pretty general at railway meetings, where a chairman had to officiate for independent shareholders. The Society had nothing to do in making accounts look pleasant, or any interests but those of the Society at large. Therefore, he did not see why the chairman in this case should not follow the railway example; and he begged leave to move that the reports which had been read be adopted, entered on the minutes, printed and circulated amongst the members.

Mr. Hardwick seconded the resolution, which was carried.

The Chairman said the next business was the appointment of officers for the ensuing year.

Mr. Hardwick read the following list, which he begged leave to move:—

President:

E. W. BINNEY, Esq., F.R.S., F.G.S., &c.

Vice-Presidents:

ANDREW KNOWLES, Esq.
W. R. BARR, Esq., F.G.S.
JOSEPH CHATTWOOD, Esq.
JOHN AITKIN, Esq.

Treasurer:
HENRY MERE ORMEROD, Esq.

Auditors:
R. P. GREG, F.G.S. | R. D. DARBISHIRE, F.G.S.

Honorary Secretaries:
JOHN EDWARD FORBES, F.G.S. | G. C. GREENWELL, F.G.S.

Honorary Curators:
MR. E. W. BINNEY. | MR. H. M. ORMEROD.

Other Members of the Council.

Mr. John Ashworth,	Mr. J. J. Horsfall,
„ Thomas Baldwin,	„ Henry Jackson,
„ Joseph Dickinson,	„ R M. Knowles,
„ R. A. Eskrigge,	„ Clegg Livesey,
„ Thomas Farrimond,	„ George Peace,
„ C. Hardwick,	„ John Wild.

Representatives of this Society at the Council Meetings of the Natural History Society,—E. W. Binney, F.R.S.; Dr. J. P. Joule, L.L.D., F.R.S., &c.

Mr. Farrimond seconded the motion, which was adopted.

The President, referring again to the smallness of the attendance, said the apparent apathy was not confined merely to the Geological Society; it was the case with the Natural History Society, and other scientific societies in Manchester. It appeared to be the fashion of the people in Manchester to treat science just at the present time with no great amount of consideration. This was probably owing to the late visit of the British Association having exhausted a deal of the money usually devoted to scientific purposes in entertaining the non-residents, and they were suffering not a little from the extraordinary exertion which then took place. The Geological Society, however, was in a good financial

state; they had no occasion to "shut up" their Society, or throw themselves upon the city authorities, as they had a pretty good balance in hand, and at their general meetings they had a fair attendance; but if the Natural History Museum were broken up, we should be considering what is to be done with our valuable museum. He hoped next year they would have some good practical papers read at their meetings, and a few excursions in the immediate neighbourhood. The Society during the last year had not had any excursions, chiefly owing to the excursions of the year before not being well attended. The secretaries had to put themselves to a deal of trouble, and if members did not attend, the trouble was hardly to be incurred a second time. Other societies had well attended excursions, and it was desirable that we should have them.

Mr. Chattwood inquired if it was not possible for the President for the ensuing year to open the session with an appropriate address?

The President said he did not think it desirable to review the progress of geology for the past year. What he would do would be simply to state the objects for which the Society was instituted, and to recommend certain subjects as worthy of special investigation. He had no objection to prepare such a paper for the next meeting.

It was agreed that this should be done, and the meeting separated after passing a vote of thanks to the chairman for presiding.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 11.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, November 28th, 1865.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

MR. PLANT, F.G.S., exhibited some pieces of flint from Presigny le Grand, from which portions had been chipped off for making flint implements.

MR. DICKINSON, F.G.S., showed to the meeting a drawing of what he supposed to be a fossil lily from the Bent Mine, near Ashton-under-Lyne.

The thanks of the Society were voted to Mr. Plant and Mr. Dickinson.

The following paper was then read:—

ON SOME OF THE

OBJECTS OF THE MANCHESTER GEOLOGICAL SOCIETY,

AND THE

BEST MEANS OF ATTAINING THEM:

BY

E. W. BINNEY, F.R.S., THE PRESIDENT.

It is now 27 years since this Society was founded at the York Hotel, under the patronage of the late Earl of Ellesmere. I was present at the first meeting, and have attended its meetings more or less frequently up to the present time, so I am prepared to speak of what it has done, and what it ought to have done. On the whole it may be considered to have been as successful as such Societies have usually been in provincial towns in England.

The Society having done me the honour to elect me a second time its President, I think it my duty to explain some of the objects of the Society, and the best means of attaining them.

First,—I will say a few words as to the name of the Society. It was called the Manchester Geological Society for the purpose of giving it a habitation where it might be found, and all communications to it could be addressed. Had it been called the Lancashire, Yorkshire, Cheshire, and Derbyshire Geological Society, it would have been difficult to find, and letters and papers addressed to it might not so readily have reached their proper destination. In addition to this, although it is, no doubt, to a great extent quite true that geological investigation, like charity, should begin at home, it is desirable not to limit too much our field of action. Manchester itself, although situate in a very interesting district for geological investigation, could afford us little scope for our labours. It is the great Lancashire coal field, with its extensions into the adjoining counties of Chester, Derby, and York—the main

source of our manufacturing greatness—that should chiefly attract our attention, a subject which will certainly not be exhausted in our time, however active and energetic our members may prove themselves, to say nothing of the salt deposits of Cheshire, and the iron mines of Furness and other districts, which must necessarily come in for a share of our notice. But the objects of the Manchester Geological Society are far wider, and of much greater extent, for they are, as defined by the Rules, to be "for the Collection and Diffusion of Practical and Theoretical Knowledge respecting Geology and Mining." Surely these objects are wide enough, and no one can fairly complain of our labours being in the slightest degree restricted so far as geology and mining are concerned.

The science of geology consists of two distinct branches—one is the observation and recording of certain facts, and the other the examination of natural laws now in operation, for the purpose of reading the past history of the globe from what we see going on around us.

It is to the first of these divisions that all of us can assist in lending a helping hand. We can record the extent, thickness, and characters of recent alluvial deposits, peat bogs, beds of gravel, sand and clay—sandstones, limestones, ironstones, shales, clays, and coals—the order of their occurrence, and the gradual change of the one into the other—their positions, joints, cleavages, and faults, and the remains of vegetables or animals found associated with them; also the occurrence of veins, and the metals they contain, beside the various metamorphic and primary rocks.

The second part of the science is far more grand and interesting. It enlists the whole range of the physical sciences to aid us in elucidating the past history of the globe. Before man will be able to read truly and thoroughly the great volume of the past, engraved on the crust of the earth by the finger of its Creator, he must be thoroughly acquainted with the physical, chemical, and

organic laws which are now in operation. The mighty effects of earthquakes, the terrific eruption of volcanoes, and the wonderful chemical productions evolved from the latter, show us something of the changes now taking place under the crust of the globe through the agency of heat. The effects of water on the surface of the earth are equally beautiful and magnificent, whether we look at the quiet and silent action of tides and currents, or the violent storms of the ocean on the coasts, the cutting and silting powers of running streams, the disintegration of rocks by the agency of frost, or the great mechanical effects of glaciers and icebergs. The chemical changes now taking place in the deposition, precipitation, and decomposition of salts and metals, or the more wondrous changes of organic chemistry, as well as the marvellous effects of living organisms, from the simple polyp up to man himself, all aid us in elucidating the past history of our planet. However, these are subjects which, sublime and grand though they are, and well calculated to elevate the mind, a Society like ours cannot hope to do much with. Our chief field will be in practical geology—that is, in the collecting and recording of certain facts—and by far the most important fact for us to direct our attention to, is our invaluable coal-field, producing, according to the latest returns, about 12,000,000 of tons of coal per annum.

Its extent is from near Buxton to Blackburn in a north and south direction; and from Bickerstaff to Todmorden in an east and west direction.

Thickness of the Deposits and number of Workable Seams of Coal:—

		Feet.
UPPER FIELD, commencing so far as yet known, with the red clays of Ardwick, and terminating with the Bradford and Pendleton Four Feet Coal		2,000
Workable Seams.....	6	
MIDDLE FIELD, commencing with the Pendleton Four Feet, and terminating with the floor of the Arley Mine		2,190
Workable Seams.....	20	

		Feet
LOWER FIELD, commencing with the floor of the Arley, and terminating with the Millstone of Gauxholme.		3,180
Workable Seams	7	
Total Thickness		8,090
Total Seams	33	

This is given as an approximation, and probably a more correct section, and more convenient classification, can be made. I give it on my own observations.

IDENTITY OF BEDS.

In the upper field the seams can be pretty well identified. Not so in the middle field, where they split and thin out to a great degree, which render them very difficult to identify. The Arley Mine, however, can be traced over a large extent of country. The beds of the lower coal-field have certain well marked characters about them, and can so often be seen in natural sections on the hill sides that they are easily identified over the whole district.

FAULTS AND DISLOCATIONS.

The desirability of noticing them—their effect on the adjoining coals and rocks, and their direction, must be evident to all. In our coal-field the great dislocations are generally filled full of red sandstones and red clays, and these dislocations appear to be the greatest as they approach the new red sandstone plain, and gradually diminish as they run up into the lower coal-measures and millstone grits of the higher country. Their direction is generally S.E. and N.W. The coal faults north of east are not of such frequent occurrence. In plans of mines and geological maps it is desirable that all dislocations, however small in extent they may be, should be laid down.

INTERNAL HEAT OF THE DEEP MINES AND THE SPRINGS OF SALT WATER FOUND IN THEM.

The temperature of deep workings should be carefully taken and

recorded, and the salt water often found in them examined, as the first may give us valuable information as to the natural ventilation and the probable depth which coals may be worked without inconvenience from high temperature; and the last may furnish us with evidence as to whether or not such saline waters are merely those of the old sea in which the plants now forming coal once grew. The expansion of the fire-damp, when it escapes from the coal, has a considerable cooling effect, and has not yet received that attention which it deserves. On the other hand, the heat generated by the decomposition of sulphides of iron is seldom noticed in the observations on temperature.

Structure of Coal.

The cleavages of the different beds should be carefully taken, and their angles accurately measured with a goniometer, so as to enable us to get some information as to the manner and time, how and when such cleavages were formed. These divisional planes, commonly known as the "boards" and "ends" of the coal, not only regulate the working of the mine, but, according to the angle the latter makes with the former, they cause the coal to be cubical or rhomboidal. The circumstances under which the rhomboidal coals of the middle field, and the cubical and caking coals of the lower field, and the vegetable remains found associated with them, as well as those under which soft or cherry, splint or bone, and cannel, or stone coals occur, and whether the quality of the coal is due to the nature of the plants composing it, or the chemical changes they have been subject to, are worth your attention. The grain of the coal is called the conical structure, as found lying horizontally near to the great Irwell, and some other faults, should be carefully observed. This structure, in a perpendicular direction, is well known in the South Wales coal-field, and is also some times met with in the Scotch fields, nearly always in the neighbourhood of faults. The latter kind of grain is most probably the result of vertical displacement of strata, while the former may be due to lateral movement. The beds of charcoal having a fibrous

structure mixed with and separating the more bituminous portions of the coal, and thus forming distinct laminæ, are worthy of your attention. In this charcoal will generally be found (vegetable structure especially) some singular oval orifices, which have much puzzled the students of fossil botany. Nodules of ironstone, limestone, and iron pyrites, found in the seams of coal, if carefully examined, will generally afford evidence of vegetable structure. The circumstances, under which the variety of coal termed "specular coal," found in the vicinity of faults occurs, should be carefully recorded; also any traces of thin beds of clay or shale in the coal should be noticed, and the direction in which they appear to thicken, so as to find out the course in which the seam is likely to split and divide into two distinct beds.

Origin of Coal.

At the present day there is no doubt that coal is merely chemically changed vegetable matter, more or less mixed with mineral ingredients. The mineral charcoal found in the coal, and previously alluded to, as well as the structure of the plants themselves, found in the nodules of mineral matter, and giving us preserved samples (hermetically sealed up) of the kind of vegetation the coal is composed of, place its vegetable origin beyond question. In addition to the above, many seams of coal show evidence of the remains of plants mingled with them. On the roofs of the coals erect fossil trees, known familiarly as "pot holes," are frequently found; whilst the floors of coals are full of the roots of plants (*Stigmariæ*), thus clearly shewing that the vegetable matter of most seams of coal grew where it is now found. Some parties contend that coal was a subacrial, rather than a subaqueous, deposit. All we can say is that in our Lancashire coal the presence of the remains of fish and shells both in cannel coal and bright coal clearly confirms the latter view.

Fossil Organic Remains.

Fishes, crustacea, shells, and vegetable fossils should be care-

fully noticed and collected, as they are not merely interesting as specimens of natural history, but are often of the greatest value in identifying seams of coal. The "cockle shell" bed, as a stratum of large bivalves (*Anthracosia robusta*), found about 46 yards above the Arley mine, at Wigan, is called, always indicates the proximity of that seam of coal, and therefore possesses interest for the miner as well as the collector. Generally speaking, fishes, crustacea, and shells will be found in black basses, cannel, and ironstone nodules, whilst the blue and light coloured shales will afford the most distinct remains of plants. In the Peel Delph sandstone, and in the same rock at other places, trigonocarpons are plentifully found. Fossil wood, showing structure, is often to be met with in close grained gritstones. Many of the lower coals in their roofs furnish an abundance of *goniatites*, *aviculapecten*, *orthoceratites*, and other marine shells.

Permian and Trias Beds.

These deposits, generally known amongst colliers as "red measures," have not been much noticed by any persons except geologists, and are little known by coal proprietors, but they are deserving of attention, as a great supply of coal exists under them, as proved by the workings at Patricroft, Astley, Bedford, and Edge Green. The beds, especially the permian ones, are of very variable thickness and uncertain occurrence, and in their lower portions contain much water. In all borings and shaft sinkings these strata should be carefully collected and preserved. It is a desideratum amongst geologists to find the carboniferous strata fairly and clearly passing into the overlying permian beds. This remains to be done in Lancashire.

Drift Deposits.

These, known by geologists under the name of "drift," whether they consist of clay, sand, gravel, or clay mixed with pebbles, and generally described in sinkings as "surface covering," "top," or "superficial deposits," ought to be carefully considered and re-

corded. They often collect the water, falling in the shape of rain, or leaking through the sides of streams, and conduct it into the measures below. At other times the strong clays are of very great service in preventing the water from penetrating carboniferous strata underneath. The only observations made by practical men on these beds are where quicksands have been met with in shaft sinking. These are generally not very pleasant reminiscences. No part of geology is of greater importance, and a vest deal yet remains to be done in it before anything like a drift map can be constructed of a considerable district. No shaft, well, or borehole should be made without recording the different beds met with. These should be registered in a book kept at the Society's rooms. If each member would collect and forward sections of the drift deposits found in the neighbourhood we should soon possess a valuable collection, and be able to classify and arrange them. By so doing a great benefit would be conferred on the public, as these beds regulate most of the surface springs, and are of paramount importance to the agriculturist in his draining and cultivating the soil. Above 20 years since I published several papers on the Lancashire and Cheshire drift. In the year 1841 I first attempted to class the drift deposits found in the neighbourhood of Manchester, in a small paper, with a map, which I prepared for the Statistical Society of Manchester. In that memoir I divided the foreign drift in the ascending order:—

(1) Lower sand and gravel.
(2) Till.
(3) Upper sand and gravel.

And I described the more modern deposits found in valleys (No. 4) as valley gravel.

This order I adopted in a paper read before this Society on the 22nd December, 1842—"Notes on the Lancashire and Cheshire Drift," and printed by this Society in their Proceedings of 1843. In that paper, in treating of the upper beds of sand and gravel, I said, "At Manchester it (the higher drift) is composed of lower

gravel, till, and sand and gravel; while at Heywood and Poynton, near the base of the Pennine chain, the beds of sand and gravel are parted by several beds of loam and clay.

Again, in speaking of No. 3 deposit, I said, "The gently rising lands of the two counties are generally composed of this deposit. It varies much, both in its composition and thickness. Near the sea, at Ormskirk, the till is sometimes found without it; but as you proceed to the east it makes its appearance, and gradually thickens until it attains its greatest thickness near the base of the Pennine chain. Not only does it increase in thickness, but it becomes more complex, and contains beds of clay, marl, and loams of several yards in thickness. The country lying between Manchester, Bolton, Bury, Rochdale, Ashton, and Stockport, for the most part, is upon it, and forms one great sandbank, which continues south into Cheshire."

The same classification I adopted in two papers, one on the drift of Manchester, and the other on the same deposits at Blackpool, printed in vols. viii. and x. of the Literary and Philosophical Society's Memoirs, as well as in a paper printed in this Society's Transactions for June, 1862.

Mr. Hull, in his communication lately read at a meeting of the Literary and Philosophical Society, divided the higher drift into (in descending order):—

(1) Upper boulder clay.
(2) Middle sand and gravel.
(3) Lower boulder clay.

The Nos. 2 and 3 had been described by myself, as also a lower gravel, of whose existence he (Mr. Hull) had considerable doubts, and considered it as merely accidental.

Now in my paper on the drift of Manchester, 11 sections of

wells and bores are given, and in 10 of these the lower sand and gravel had been met with, thus showing that it can scarcely be considered to be merely accidental, as Mr. Hull states. In many other sections since examined in Lancashire this deposit has also been found under the till. With regard to the upper bed of boulder clay, Mr. Hull stated that I had alluded to it; but Mr. Hull considered it to be quite as important as the lower, both in thickness and area.

The old term "till" is as good as that of boulder clay, and as it has been long employed, there is not much use in changing it. During the last twenty years I have collected many facts, which I intend to publish when I have completed my collection; but these did not show one bed of clay or marl which could be called upper boulder clay, but several; in fact, there were numerous intercalations of it in the sand and gravel, one of which I have seen occurring at Kersal Moor, entirely surrounded by sand. To show the complexity of these deposits, and the difficulty of reducing them to two beds of till or boulder clay, I can name two sections, one near Hyde, where six beds of till were met with, and the other at Outwood, where two beds were found.

It is for the members of the Society to determine which of these classifications is the most natural and convenient, and whether a better than either cannot be found.

Ironstones, Building Stones, &c.

In our Museum we should collect specimens of the ironstones, building stones, flagstones, fire-clays, clays suitable for alum making, and other useful minerals found in the district, as a local collection of such objects is of the greatest importance. Having thus cursorily glanced at the chief geological objects of the Society, I will direct your attention to the mining portions. In doing so I must claim the indulgence of my audience, many of whom, no doubt, are far more conversant with the subject than I can be supposed to be.

Boring and Searching for Minerals and Water.

Although some practical men possess great experience in these departments with their old-fashioned tools, many improvements may be looked for in boring. In most of the new contrivances the inventors appear to have been scarcely aware of the numerous changes in the different beds they have to perforate. The tools may do all very well for sandstone, but are quite ineffectual in dealing with stiff clay. Some of them also may succeed in deep and wide bores for water, but they are out of the question, owing to their expense, in simply proving minerals. By the improved apparatus of Messrs. Mather and Platt, of Salford, good sized cores of the strata and minerals met with are brought to the surface, so that we not only know the inclination of the beds, but have sufficient quantity for analysis of the minerals.

Position of Shafts.

It has generally been found more convenient to place a pair of pits near together, with an engine between them, one being the upcast and the other the downcast pit; but in fiery mines great safety and advantage may be derived from having the upcast shaft on the extreme rise of the strata. This will, doubtless, increase the expense, but it is a question whether or not such increased expenditure will not be repaid by the greater facilities for ventilation, and freedom from explosion. The area of the upcast shafts should also bear a certain proportion to the downcasts. In tubbing out with cast iron the foul water of old workings great care should be taken in protecting the metal with brick walls and strong groutings of broken sandstone and hydraulic lime, as lime appears to possess preservative properties for protecting iron from the destructive action of water charged with mineral acids.

Steam Engines and Machinery.

In this district it will be scarcely necessary for me to direct your attention to the importance of having plenty of power and first-rate machinery for drawing minerals and pumping water.

Conductors, Cages and Ropes.

The relative advantages of wooden conductors and wire rope ones may be discussed. The shape and construction of cages, especially those for holding workmen—the advantages of wire and hemp for ropes—and the various contrivances to prevent accidents from breaking of ropes, sticking of cages, or drawing over the pulleys, are worthy of your attention, and cannot fail to afford useful topics for conversation.

Ventilation of Mines.

The consideration of this most essential part of good mining will deserve your best consideration, for no one will now question the great importance of sufficient airways, judicious splitting and conducting of air, and a good supply of the air itself, with substantial air-tight stoppings, and other contrivances. The time has gone by when safety-lamps, as they were falsely termed, could be used as a substitute for good ventilation. The lamp may be used as an additional precaution, but never as a substitute for ventilation. The position, size, and construction of furnaces, as well as exhausting apparatus, steam jets, and other plans for withdrawing and supplying air to a mine, will afford you ample scope for investigation and improvement.

Fires in Mines.

Another subject worthy of your attention is the extinguishing of fires in mines. It appears easy to put out flame, but a smouldering fire in the coal is not by any means so easy to overcome.

Drainage of Mines.

The different machinery now in use for draining mines, the cost of driving adits, and their relative advantage against pumps, and the best plan of tapping water in old works, are subjects worth the attention of all miners. Besides the best means of getting water from a mine, it will be more desirable, when practicable, to prevent its getting in, by carefully approaching old flooded workings,

streams, and outcrops of coal near sand and gravel. In many instances water might be pumped at a higher level than it now is if a little better feeling existed between neighbouring proprietors, who, in this district, like others, may think it as well to give their neighbours a little more water as lend them facilities for preventing its coming, or taking it away. Portions of the coal-field are so situated with respect to water, that large sums of money would be saved if the water was pumped at a joint expense, and a drainage-rate levied on the whole of the proprietors, in a similar way to that adopted with regard to the drainage of large plots of land belonging to different proprietors in Lincolnshire and other counties.

Different Systems of Working Coal.

The "pillar and stall" and "long wall," and the various modifications of both these plans of extracting coal, require your careful consideration. It is too much the custom for persons long acquainted with one system, proved to be adapted to a certain coal-field, to wish to introduce it into another district, without looking at the different inclinations of the strata, the character of the roof and floor, and many other circumstances. It will be for you to judge what systems are best fitted for cheaply, safely, and expeditiously working different seams, so as to obtain the greatest quantity of merchantable coal. The relative advantages of getting coal by blasting and wedging are subjects well worth discussing. The practicability of cutting coal by machinery has been advocated by some, and several patents taken out to secure the inventions. Although up to this time these attempts may not have succeeded equal to the expectations of the inventors, there is no reason to doubt but that machines will be produced capable of cutting seams of coal under certain conditions. Whatever can be done in this matter we have reason to believe will be effected in this district, where machinery has worked such wonders.

Workable Seams.

What really is a workable seam, and what is not, are points

which require much consideration. In some cases seams of coal 2 feet 6 inches in thickness will not pay for working, while, at other places, seams of 8 inches in thickness have been worked; so it is very difficult to speak off hand what seam is workable and what is not. In some cases an inferior coal may be worked with profit in conjunction with the beds of fire-clay and ironstone in connexion with it. These facts show how uncertain it is to say beforehand what supply a given coal-field is capable of yielding, so many data remaining yet to be ascertained before we can pronounce whether this or that bed should be taken into the account, or should be rejected as unlikely ever to become available.

Waste of Coal.

Coal mines in this country are worked, not for the national good, but for individual profit, and generally with a view to the greatest profits in the shortest time. Landlords in some instances tie their tenants down by exacting large minimum rents, which, although doubtless calculated, and often necessary, to compel the tenant to get a large quantity, does sometimes compel the latter to commit waste, especially when the royalty is at so much per ton sold. The immediate interest of the landlord and tenant, but especially the latter, whose interest ceases after a term of years, has too often been at variance with the true interests of the nation. It would be preposterous to dictate in this country what either landlord or tenant should do with their property, still it is right and proper that the greatest possible profit should be aimed at, but with the least possible waste. It is pretty certain that considerable portions of coal are lost by bad working, often caused by a too eager desire to realize profits, and pay heavy minimum rents. It also very frequently happens that in working the best seams of a district sufficient care is not always taken to preserve uninjured higher and less valuable seams, which, at a future day, may afford an ample return to the miner. You will deserve the thanks of the nation if you succeed in diminishing any of these causes of waste. Societies like this, having many practical men in them, can do much if they are inclined.

Duration of Coal.

The production of coal in Great Britain, which may safely be put down at ninety millions of tons per annum, is, no doubt, an enormous amount, still there is little fear of the nation being short of coal for a long time. The estimates put forth by authors that our coal-fields will last for thousands of years, or will be exhausted in a short period, are mere guesses, and often made by parties who have the slightest information possible on the subject they so confidently write upon. The quantity to be obtained will a good deal depend on the price which can be afforded to be paid for the coal. At what depth coals may be wrought in our explored coal-fields, and how far we may follow them under the permian and trias formations no man can at present tell. For the period of the last 20 years, whether owing to the high rents paid to lessors, or the production being ahead of the demand, I cannot say, but it is certain that the capital invested in coal mines has not yielded a large return to the coal masters.

Depository of Mining Records.

It is well worthy of your consideration whether or not it is desirable for the proprietors and tenants of coal mines to form a depository of mining records. I am aware that considerable jealousy exists amongst coal proprietors as to showing their plans, and no doubt in some cases there is good reason for it. But cannot plans of worked out collieries and records of old shaft sinkings be deposited in some place of safe custody, and arranged so as to be easy of access for the purpose of reference? This is a subject which deserves your attention.

Gases found in Mines.

These consist of fire-damp, black or after-damp, and choke-damp. The first, known by chemists under the name of light carburetted hydrogen, is just the same as the gas which arises from decomposing vegetable matter at the bottom of our pools of water. It is generally found in the coal, and is no doubt formed by the

decomposition of the vegetable of which the coal consists, but it sometimes comes out of the roof from beds of black bass and small seams of coal lying above. Owing to the different proportions of atmospheric air with which it is mixed it is more or less "sharp," in the language of colliers. Black, or after-damp, is chiefly composed of carbonic acid, with a little carbonic oxide, and a greater excess of nitrogen than usually exists in common air, and occurs after an explosion of fire-damp. Choke damp is carbonic acid more or less mixed with atmospheric air. It escapes principally from the roof, and in greatest abundance from the cracked roof of old workings, and from the neighbourhood of beds of ironstone. The only way to deal with these gases is complete and thorough ventilation. By this I do not mean so many thousand feet of air measured in the return air-course as circulating through the mine, but a sufficient quantity of air, judiciously split, carried right up to the face of all the workings, and circulating over every portion of the mine at all likely to contain gas. Instances may occur when fire-damp can be tapped and discharged by means of bore-holes, and by cutting through the roofs so as to liberate a good deal of pent up gas. The lives and health of the men, as well as the property of the owner of the mine depend on good ventilation; and it is therefore beyond all question the first thing to be attended to in a mine. No lamp should be permitted to be used by a common collier in a mine until this be done.

Lamps.

Many modifications of the safety-lamp of Sir Humphrey Davy are worthy of your careful attention. Whatever has been done since the time of this illustrious man, certain it is that we have not learned much more of the laws of combustion and the nature of flame since his time. I shall not go into the great number of lamps which have been introduced to the public, but merely suggest that in all your endeavours to procure a thoroughly safe lamp for mining purposes, it will be necessary to secure the knowledge of the scientific chemist united to the practical knowledge of an

experienced collier, long accustomed to the use of a lamp in a fiery mine, in order to obtain a safe and efficient lamp.

Some of the best means of attaining the Objects of the Society.

There now remains but one other topic to be considered. In what way can our objects be attained? Your safest guide on this subject will be the example set before you by the most ably conducted and prosperous societies in our own and foreign countries.

1st.—Before everything it is necessary that members should take an interest in the Society, and not merely be members, paying their annual subscriptions, and doing nothing else. The value of such members can never be estimated at more than £1 per annum.

Public meetings ought to prove one of the most efficient means that you can employ. At present, in order to suit the country members, the meetings are held at the most inconvenient day and hour to town members. It would be desirable if the holding meetings at three o'clock on Tuesday be continued, that other evening meetings be held for the convenience of the town members. If the geologists and mining people met together more frequently than they have done, and freely discussed the subjects with which they are best acquainted, they would enlarge your mutual information, remove unfounded prejudices, and lead to the adoption of practical improvements. Up to this time our Lancashire coal proprietors have not attended the meetings of this Society in the numbers, or taken the interest which they did in the late meeting of the Northern Institution of Mining Engineers, held in this city during the past summer. It may be desirable to hold meetings in some of the large towns of Lancashire and Cheshire, as was formerly done in the early days of the Society, and have geological excursions to districts worth visiting.

I will now name a few subjects which I recommend should be

discussed at our meetings, but before doing so I would suggest to the members the desirability of compiling from actual sinkings and admeasurements a vertical section of the strata composing the great Lancashire coal-field, commencing with the lowest millstone grit, and terminating with the highest carboniferous beds yet discovered. Mr. J. Dickinson, F.G.S., and Messrs. Hull and Green, of the Geological Survey, have supplied us with most of the materials, and it can be accomplished without much difficulty:—

A full description of the silurian strata of North Lancashire and the fossils they contain.

The origin and occurrence of the valuable beds of hematite iron ore for which the Hundred of Furness has long been so celebrated.

The identity and range of the lower coals from Newburgh on the west, round by Chorley, Blackburn, Rochdale, Oldham, Staleybridge, Mellor, Whalley Bridge, Ipstones, and Wetley, in the Potteries.

The extent and nature of the dislocation west of Billinge, which brings in the Rainford coal-field, and the identity of the latter seams of coal with those found at St. Helens and Wigan.

A comparison of the Wigan seams with those of Dukinfield and Poynton, and the running together and thickening and thinning of such seams, and the directions such changes take place in.

The nature and extent of the great dislocations in the coal-field, filled with red sandstone, and clays, and limestones, and the practicability of following the coals underneath the permian and trias strata.

Descriptions of the coal-fields of Burnley and Black Burton.

The geological structure of the country between Manchester and Radcliffe, Whitefield, Middleton, Oldham, and Ashton-under-Lyne.—At the present time nearly the whole of the country six miles north and east of the Manchester Exchange, with the exception of the Manchester and Moston coal-fields, is simply coloured red, and little or nothing known of the valuable coal-field lying under it. It is surprising to me that the landlords of this district have not investigated their property by judicious boring, but our Society should do what it can to collect and record information on the subject.

The nature and extent of the great fault at Roecross, which separates the coal-field at Staleybridge from that of Mottram-en-Longendale.

The characters and beds of the drift deposits; how they vary from the sea coast up to the sides of the Pennine chain, the height they reach, the organic remains they contain, and whether or not some of them have passed over the hills and gone into the eastern water beddings of Yorkshire and Derbyshire.

The nature and origin of peat bogs, their growth and age, what decomposition the vegetable matter composing them have been subject to at high and low levels, and the organic remains found in them.

The foregoing are some of the geological subjects which may be discussed with advantage.

Numerous mining topics will suggest themselves to the members, as to the area and position of shafts, the best drawing and pumping machinery, the different plans of tubbing shafts, the form of cages and conductors, the position and construction of furnaces, the approaches to pit bottoms, the conducting and splitting of air, the construction of stoppings, trap doors, and brattices, the best plans of ventilation, the advantages of the pillar and stall and long wall systems, and their various modifications to different mines, besides many other matters previously noticed by me.

Museum.

It will be most desirable for the members not only to send the fossil organic remains met with in their workings for preservation in the Society's Museum, but also to collect samples of the different strata passed through in sinking their shafts, for reference. These can be preserved in boxes divided into small compartments, and will form a valuable collection for reference, as many of the fire-clays, ironstones, and other deposits passed through in sinking a shaft, and not noticed in the anxious pursuit of a seam of coal, may hereafter prove to be of considerable value.

Our Museum was commenced with a few specimens in a house, No. 29, Faulkner-street, and was soon enriched by a valuable collection of coal plants, presented by the late Mr. Scarisbrick. We then moved to a house in St. Peter's Square, where the Museum was largely increased by the fine collection of the late Mr. George Cumberland, of Bristol, purchased by Mr. James Heywood, F.R.S., and presented to the Society. The late Mr. J. E. Bowman, F.G.S., added a good suite of silurian fossils, collected by himself in North Wales. In 1843 the Museum was removed into the Royal Institution, where it was located during the first visit of the British Association to Manchester. In that

building it remained for some years, when it was removed to the rooms of the Natural History Society, in Peter-street. Here it received the excellent collection of fossil coal plants, formed by the late Mr. Matthew Dawes, F.G.S., and many other additions. It is now in first-rate condition, well arranged, and may fairly compete with most provincial collections. For educational purposes, whether for the geological or mining student, it would be of invaluable service, supposing we had large classes of students to avail themselves of its benefits. It has always been perfectly free and open without charge to the public, and yet, after 27 years of existence, it is at this moment in a critical position. For the sake of economy we some years since joined our fortunes to those of the Manchester Natural History Society, not being able to provide a suitable building out of our own funds. This institution is likely to be removed to some other locality, probably to one of the Parks of Manchester and Salford, or, worse still, it may be divided or sold, and then we shall have to determine what is to become of our collection. If we cannot raise funds to continue the Museum in a separate building of our own, we have no help but to follow the misfortunes of the Natural History Society. It will be strange indeed that a city of about half a million people, situate on one of the richest coal-fields in the world, and in the midst of a vast population, second to none in industry and intelligence, cannot support a Geological Museum already formed.

The colliery proprietors take little interest in it, and the same may be said of the book geologists. Really, after my long experience, I begin almost to doubt whether or not Manchester and the surrounding districts require a museum as an educational establishment; but I firmly believe that many self-taught men of science in humble life will visit one when they know that it is open freely to them.

Library.

A good library of standard works on geology and mining should

be provided for the members, and all the modern geological and ordnance maps on a large scale should be procured.

Education of Officers and Men.

One of the chief means by which we may attain the objects of our Society is, doubtless, the education of both the officers and men connected with mining.

There is certainly an excellent school of mines in Jermyn-street, London, established by government, but is it not possible to have in Manchester an institution connected with our Society for the teaching of geology, mining, metallurgy, engineering, and chemistry, where our officers may have the advantages of a scientific training, in addition to their sound practical knowledge in a mine? If this is not practicable at present, and I must confess that I do not like to multiply societies and institutions in Manchester, cannot we establish in connection with Owen's College Professorships of practical mining and engineering and geology? These would be steps in the right direction, and the creation of other chairs might follow. What is much wanted at present is, that our scientific men should be more practical, and our practical men more scientific. We need not fear over-educating our mining officers.

We should do all we can, as a Society, not merely to encourage and support the education of the rising generation, which can only be done effectually by a broad and liberal system of national education, but by frequently lecturing to underlookers, firemen, and colliers, on the nature of the gases found in mines, their origin, and likely places to be met with, under what circumstances they become dangerous, the different lamps now in use, and how and when they become perilous. Nothing appears to me more alarming than to place a scientific instrument like a safety-lamp into a poor ignorant miner's hands, without giving him some knowledge of the nature of the gases found in coal mines, the

principles of the construction of the lamp, and the circumstances under which the lamp becomes a dangerous lamp, and not a safety-lamp.

The education of boys requires a good deal of consideration, for it is no doubt certain, as was remarked to me the other day by a most intelligent mining engineer, that if a boy is not early introduced into a pit it is very difficult to get him to go there at all. This subject must not be overlooked in any plan of education for our mining population.

Publication of Transactions.

Bringing before the members and the public valuable papers on geology and mining is no doubt of advantage to the Society, but great care should be taken in printing nothing but what is new and useful. Many Societies seem to pay more attention to the quantity rather than the quality of what they publish. At the close of each session the President of the Society should review the proceedings of the past year in a short address.

I shall now bring my address to a close, and, in doing so, I cannot do better than use the words of an esteemed friend, Mr. J. W. Kirkby, of Sunderland:—"Let us do our part thoroughly. It is a work of which we may be proud of being labourers. For where is there a pursuit more honourable than that of an honest investigator of Nature? Or where objects so pure and noble as those attained or grasped at by the students of physical science? The wonder is that man should have been so long on the earth and know so little about it; for it is scarcely a century ago that he can be said to have fairly made up his mind to work out its history, its laws, and unravel as near as he can its creation. Some will tell us that in so doing he is striving after what he will never reach, or that it is wrong and impious to look so close and search so deep. But who knows? Not they certainly. Men who would come into the world and dare to leave it with no thought or enquiry

as to what it is and whence! Men who cannot see that there is something great outside of themselves, or that they form part, though perhaps but a trifle, in the whole of some grand and universal scheme. Such men may laugh and say hard things of our pursuits, but could such as they always have ruled in the world, we should have been in the Stone Age still, living the life of the beasts on which we preyed. Never was there one step made in advance in the cause of knowledge and civilisation but they uttered their bitter protests against it as an irreligious and dangerous thing. Doubtless their far ancestors would hold by the chipped flints of Amiens as the only proper tool for man long after the advanced minds of the period were going a-head with their superior weapons and utensils of bronze; just, indeed, as their descendants in later age cursed and tried to tramp out the brightest set of moral truths the world has yet seen.

But enough of them. Our path and theirs are as wide apart as the poles. For as students of geology we hold, in common with all who are working in other sections of natural science, that we ought to know as much about the universe we are in as our body, mind and soul can possibly bring within our ken. We hold it as a right and duty that we may search as close, as deep, and as far after knowledge as ever our intellects will carry us, and that there is nothing either in mind or matter that we may not legitimately try to fathom and understand. That we may often fail in our search we admit. Better than we have failed before us; but failure often shows the way to success to those who come after, and what may baffle the whole intellect of one generation may be won by the perseverance of another. By thus boldly seeking after knowledge we firmly believe we are doing right, and not wrong. For we cannot conceive that there should be any created thing so trifling as to be unworthy of our notice, nor yet anything, be it ever so great, that can be above our aspirations."

A vote of thanks was passed to Mr. Binney for his Paper, and a wish was expressed that it might be published in the Transactions.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 12.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, December 19th, 1865.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

Mr. John Heelis presented to the Society a specimen of coal found between Mount Olympus and the Bay of Draniska, in the Gulf of Salonica. It lay in a regular series of three beds. The coal made about 20 per cent. of ash. Similar beds were also found on the mainland, behind Samos. The specimen was found by Mr. Freer. The Pasha of Egypt was said to have a concession of this coal, and as railways were being made in the district, the presumption was, that if these beds produced plenty of coal, the coal trade of Constantinople would suffer.

Some conversation followed as to the nature of the coal, Mr. Greenwell considering that the specimens bore a close resemblance to the Berwick coal, and a more distant resemblance to some of the Tyne steam coal; and the President remarking that it appeared to unite the characteristics of cannel and splint coal.

The thanks of the Society were presented to Mr. Heelis for his contribution.

The following paper was then read:—

SAFETY CAGES;

By J. J. Horsfall.

According to intimation, I beg to draw your attention to the subject of "safety-cages," a subject, which in my opinion, has not received that careful consideration at our hands which its importance claims. This will be admitted by all when we think of that most uncertain, most costly, and most fatal danger resulting from the breaking of winding ropes or chains. For whether the cage be laden with merchandise or men (as in the fatal catastrophe which occurred recently at one of the pits of the Kirkless Hall Co.) it is impossible to regard such accidents without horror, and it is incumbent upon us to use every possible means to prevent these dreadful calamities; hence the necessity for giving the greatest publicity to any invention or arrangement which in its application would be the means of preventing such appalling accidents as at times occur.

Those of you who were present at the meeting of the North of England Institute of Mining Engineers, held at the Royal Institution in this city in July last, may remember that a paper was read by Mr. Marley, on the subject of safety-cages, for the purpose, as he said, rather of provoking discussion than of indicating any very promising method or means of protection. On this occasion I not only wish to provoke discussion but I am pleased to think that I can show some promises of relief, and if at the close of the discussion I invite, you are of the same opinion, I shall feel amply rewarded for my efforts in drawing your attention to it, as all of us are deeply sensible of the obligation we are under both to ourselves and

society, to do our very utmost to reduce the dangers surrounding our men in their perilous occupation. That familiarity with danger breeds a contempt for it amongst our workpeople, we have most abundant proof, for while we take every possible precaution to protect them in their vocation from the dangers incidental to it that science can suggest, and the most rigid and careful inspection enable us to enforce, we are not unoften reminded that one of our most subtle dangers is the wilful recklessness of the men.

I do not purpose in this paper to occupy your time in describing the various devices that have from time to time been submitted to us under the title of "safety-cages," but I may state here that I have hitherto opposed the adoption of most of the appliances brought under my notice from a conscientious conviction, that, rather than adopt the unpromising, complicated, and in most instances useless apparatus that have been brought before us, it would be better to keep the need unsatisfied so as to invite a more skilful consideration of our wants.

Judging from the paper read at our meeting in July, to which I adverted before, I consider that the most recent inventions referred to on that occasion went far away back from the apparatus patented a long time ago by Mr. Owen, of Halshaw Moor, or more recently by Messrs. Dodman & Bellhouse, of Rochdale. I scarcely like to name as safety appliances such heavy, cumbrous and costly things as Taylor's, lately illustrated in the Mining Journal, or that of Callow's, referred to at the meeting in July last.

I wish particularly to draw your attention to a safety apparatus just recently patented by Mr. Jubal Broadbent, of Rochdale, and having seen it at work practically, and applied both to wire rope guides and wood ones, at the Kirkless Hall Co.'s Works, I have no hesitation whatever in pronouncing it a reliable safety apparatus; and in my own mind I feel convinced that we need fear no longer

the disastrous consequences we have hitherto been liable to from the breaking of ropes and chains.

Before I conclude, it is only right that I should observe, both on Mr. Broadbent's behalf and my own, that he owes my favourable regard and this favourable mention of his name to his most valuable discovery alone; as to the moment of his calling on me to exhibit a model of his invention I had never even heard of his name, and my only reason for bringing his safety apparatus under your notice is, as I have before stated, the feeling deeply sensible of the obligation we are under both to ourselves and society, to do our very utmost to reduce the dangers surrounding our men in their perilous occupation.

A description of the working of the apparatus is scarcely necessary after seeing the sketch or model; but I may observe its action is independant of any complications, therefore incapable of derangement either from violence or neglect, being simply a weighted eccentric, falling into action by its own gravitation on the slackening or breaking of the rope or chain which by its tension keeps it out of action.

Mr. Broadbent, the inventor, produced a model of the machine, which he worked and explained.

Several questions were asked, the action of the apparatus by gravitation alone questioned, and Mr. Greenwell and other gentlemen suggested points of resemblance to other patents. The discussion was closed by the President observing that the patentees of the various inventions knew very well how to protect their own interests.

The thanks of the Society were then given to Mr. Horsfall and Mr. Broadbent.

The following paper was then read :—

ON THE

UNION OF THE GANNESTER AND HIGHER FOOT COAL MINES AT BACUP;

TOGETHER WITH SOME REMARKS ON THE CIRCUMSTANCES UNDER WHICH IT OCCURS;

By Mr. John Aitken.

In the admirable inaugural address, delivered at the last meeting of this Society, the President, among many valuable suggestions made for the guidance of its members, pointedly referred to the necessity of each one being vigilant in collecting and recording all facts and phenomena possessing a geological interest, which might come under his observation; and that this should be done more particularly with reference to the great Lancashire coal-field, on the various sections of which, the major part of the members have the most frequent opportunities of pursuing their geologic investigations. Much has already been done in this field, taking into consideration the few years which have elapsed since the study of geology was elevated to the rank of a science, yet a great amount of hard work, and close and accurate observation remain to be accomplished, both in the field and in the laboratory, as well as with the pen, before the numerous difficulties, with which the science is surrounded, can be removed or overcome.

The importance of this suggestion of the President cannot well be over estimated, for it is upon this basis that the superstructure of all scientific, as well as other truth, must be raised, all true deductions made, and all real progress founded. If this be actively carried out, and each member contribute according to his opportunities, the present session upon which we have just entered, will, I hope, bear favourable comparison with any preceding one, either as regards the number or value of papers contributed, the attendance at the meetings, or the interest evinced in the success of the Society. The

earnest desire I feel for the attainment of this object, and the extended usefulness of the Society, will, I hope, be accepted as in part a justification for having ventured upon these remarks, and also in offering the following brief particulars on the subject which forms the title of this paper.

That particular portion of the coal-field found occupying the hilly district surrounding the town of Bacup, consists of the lower division of Lancashire coal-measures, or "Gannester series." In it are found three workable coal-beds, viz., in ascending order,—the Sand Rock Mine, the Gannester or Mountain Mine, and the 40 Yards Mine; in addition to these there are four or five beds, all of which are, however, either too thin or too indifferent in quality, at the present price of coal, and with the appliances now in use for getting them, to possess any commercial value.

One of the three seams here referred to, is usually found about fourteen yards above the Gannester coal, and from its situation with reference to that bed has been appropriately named, by Mr. Dickinson in his valuable paper, "On the coal-strata of Lancashire," the "Higher Foot Mine." It is also known as the "Bullion Mine," from the occurrence of numerous circular concretionary nodules in the coal, and in the black shale overlying it.

The Gannester or Mountain Mine is generally known in the neighbourhood of Bacup as the Yard Mine, and Five Feet Mine respectively. The former name has reference to it before it becomes united to the overlying Higher Foot Coal; and the latter is adopted where the two are found in combination. The average thickness of the Yard Mine is from thirty to thirty-three inches; the coal is good in quality, and is generally used for domestic purposes, it has a stone roof, which in some instances attains a thickness of upwards of sixty feet, and in both the coal and the roof there is an entire absence of the nodules or balls before referred to.

After the union of the two beds, however, a marked difference takes place in the thickness and quality of the coal, the character of the roof, and in other respects. The coal here attains a thickness of from four feet to four feet six inches, and even in some instances to five feet; it is not so good in quality as the Yard Coal, and is consequently better adapted for the purpose of generating steam than for domestic use; and distributed throughout its entire mass are found numerous balls, generally named "bullions." The roof is a strong, black, finely laminated shale, in which are found the flattened nodules before referred to, and known as "baum pots."

The union of the two mines takes place about one and a half miles east of Bacup, the line of contact having the direction of S.E. and N.W. At this point a sudden depression of the floor of the Yard Mine occurs, which, for a short distance, dips at an angle of 10° to 12°, thus allowing space for the intercalating rock roof of the Yard Mine to be interposed without elevating the general level of the Higher Foot Coal, or otherwise interfering with the general easy gradient of declination, averaging 2° or 3° to the south.

In approaching the point of junction from the Five Feet Mine, a very attenuated band of stony shale is first encountered in the coal, about twenty inches from the top surface, which slightly gains in thickness for about seventy yards, when it abruptly swells out, and a rough contorted, crumpled up mass is presented, which in the distance of a few feet attains the thickness of eighteen inches; this body presents a very uneven and irregular surface to the lower bed of coal, has numerous carbonaceous markings and impressions of the usual coal vegetable forms on its under surface, (although I

failed to detect their presence in any other part of the mine), and is much marked with slickensides, having fine striæ running in the line of the dip. The coal also increases in thickness in the same direction, and just before the abrupt thickening of the interstratified mass, it attains its maximum thickness, and is found from five feet six inches to six feet six inches, and even in one instance, nine feet thick. After its division into two members, the lower one or Yard Mine descends at an angle, as previously stated, of from 10° to 12° for a short distance, and thence at a more gentle rate. A few yards from this point it measures three feet six inches thick, from thence it gradually thins away, until its average thickness of thirty to thirty-three inches is reached. The thin coal, so far as I was able to observe, appears to continue in its regular course, without any special disturbance or interruption.

Near the point of separation, bright smooth surfaces, having the appearance of slickensides, are pretty numerous in the bedding of the coal; one is especially noticeable about eight inches above the floor, from the brightness and polish of the two surfaces there in contact; and instances of joints running at an angle of 45° to the board or cleavage of the coal, having their surfaces covered with a thin coating of oxide of iron, giving a brown rusty appearance to them, are plentiful. To this particular class of joints, sometimes found in the vicinity of faults or disturbances in the coal, the miners have given the euphonious name of "gagantails." I was, however, unable to learn the origin or meaning of this word, beyond its application to the particular character of joints here described.

The two beds appear to become thoroughly incorporated and united into one, do not exhibit any line of parting, nor yet show any tendency to separate at the plane of union when they are worked. In this respect they differ from the Dudley Thick Bed, the thirty feet of which is built up of 12 or 14 separate and distinct beds, all of which, though generally found in contact with each other, yet have distinct planes of bedding, causing them to separate

from each other when being worked with the greatest ease. This property enables the miners to win the coals with greater facility, and with less labour and risk. The same thing obtains also with two beds worked in contact with each other at Low Moor, Yorkshire, and at other places.

From a consideration of the foregoing facts, I am led to infer that a slight and gradual subsidence took place of that area now occupied by the Yard Coal, after the deposition of the vegetable matter which went to form the thirty or thirty-three inches of coal composing that bed, causing a submersion to such a depth beneath the water as to allow the deposition of sufficient detritus to form the beds of rock overlying that mine, and separating it from the thin coal above. That such a subsidence as here indicated took place after the formation of the Yard Coal, is evinced by the slickensides in the roof, the direction of the striæ, the rapid dip of the floor, the polished surfaces of the coal, and the diagonal joints or cracks, as well as by the contorted character of the roof. The disturbance does not, however, appear to have been of so violent a character as to amount to a positive fracture of the coal, or to fairly merit the name of "fault" or "throw."

It would further appear that the surface, over which the Five Feet Coal was then in process of formation, remained stationary and undisturbed, and that the operations of nature were not in any way interrupted, nor were the continued accumulations of the coal forming material at all interfered with by the alteration of level of the area, which had suffered subsidence. This view is supported by the fact, that the coal of the Five Feet Mine is considerably thicker than the aggregate of the two mines while separate; thus conclusively showing that the formation of the coal was in operation during the period of submergence of the Yard Coal. This period of rest of the surface, occupied by the Five Feet Coal, must have continued until after the formation of the Higher Foot Mine, when the whole area, occupied by the Yard and the Five Feet Mines respec-

tively, was submerged; and the whole surface received uniformly the superimposed shales, forming the roof of the two mines, with its imbedded nodules and fossils. That this latter submergence took place beneath the sea, or at all events in salt water, is more than probable, from the presence of numerous fossils, whose habitat when living was in that element.

The space allowed for a short paper like the present one, precludes the possibility of entering more fully into the arguments and speculations which the subject under consideration might call forth. Those who wish further to pursue it, may find an admirable essay on the "Origin of Coal," by Mr. J. E. Bowman, among the earlier Transactions of this Society; the remarks, on this question, by Mr. Jukes, in his "South Staffordshire Coal Field," may also be read with interest; and Mr. Dickinson, in his paper previously referred to, gives an interesting instance of two seams of coal in the neighbourhood of Over Darwen, which approach so near to each other at one point as to be worked as one mine, and which, after continuing so for some distance, again diverge, and become so far divided as to be treated as separate mines.

A vote of thanks was given to Mr. Aitken for his paper.

The President said the term Gannester had lately been imported into this district, where it had never been heard until the ordnance survey was commenced. The coals had always been called the Lower Coals; and "Gannester Series," he thought, was not a good title. Gannester really was nothing but hardened clay. There appeared to be three coals in the neighbourhood of Bacup, but in this district there were the 40 Yard Coal, the Foot Coal at Oldham, the Gannester, the Lower Foot at Walton, the New Mills Coal, and the Sandgelf, making six different beds now being worked. In the neighbourhood of Dulesgate, the Lower Foot or "Spanish juice"

Coal was hardly seen, whereas the Gannester was about five feet eight inches; but striking across the country, in the direction of Walton, the Gannester was only about two or three inches thick, while the Lower Foot became quite thick.

Mr. Dickinson said those who had attempted to trace the Upper Foot and the Gannester Coals through, from the Rochdale to the Burnley district, must have noticed there was a remarkable change taking place in the neighbourhood of Bacup, a little to the north. At the same time, tracing the Gannester Coal to Bacup, it would be found that the Upper Foot Coal kept its place. The same regularities of the seam continued along the range of fault from Littleborough to Bacup. There was a mine lying over the Gannester Coal which occupied the place of the Upper Foot Coal throughout the northern coal-field, but it became very much thinner in some parts than others. A similar junction to that described in the paper was to be seen in the Wholaw Nook Colliery. There the divergence of the two seams took place by the intervention of a kind of wedge between them, and it was also to be found within one or two hundred yards to the side of one of the large faults that ran through the district. In the same colliery the seams were worked as one bed, till the diversion between the two became so great that the upper was lost. In a colliery a little further north, the seam was also to be met with across a large fault near Burnley, and there, although there was no marked divisional plane between the upper and lower; the upper part of the seam was a granular structure, while the lower had more the appearance of the Gannester. He did not, as was well known, agree with Mr. Aitken as to the way in which these subsidences took place. The facts mentioned in the paper were striking illustrations of the simultaneous growth of all the coal-fields.

Mr. Eskrigge said the fact that there was no recognisable difference between the lower and upper coals showed there had been no cessation of the deposition of carboniferous matter. The paper

had clearly shown that there must have been subsidence all along in one portion, while the other was still receiving additions of vegetable matter.

Mr. Plant, while endorsing Mr. Aitken's theory, said he thought it was likely to lead to mistakes, to apply as a rule, general laws to local questions.

The President said Mr. Aitken was especially entitled to thanks for having read a paper based upon investigations in his own neighbourhood, and his example might be followed with advantage to science generally.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 13.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, January 30th, 1866.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

The President received a vote of thanks for his presentation of a copy of "A description of some fossil plants, found in the lower coal-seams of Lancashire and Yorkshire."

The President said he wished to correct a misreport of some remarks he made at the last meeting. What he said was with reference to a coal-mine at Quarlton, not Walton, as reported, and he spoke of Sand Delph, a mine near Bacup, not "Sand Guelph."

Mr. Aitken exhibited three slabs of fine sandstone, obtained from quarries worked in the higher part of the lower coal-measures, near Bacup.

He also exhibited a specimen of *Stigmaria ficoides*, obtained from the floor of the Gannister or Five Feet Mine, of Bacup; this specimen showed the manner in which that root bifurcated. And

also a Cranium, which was discovered by Mr. Townsend, of Townsend Fold, near Rawtenstall, in the valley of the Irwell, about a mile and a half down the stream from the point at which the two antlers and other horns were found some time ago, and exhibited at a meeting of this Society, on the 26th of April, 1864. It was found in excavating for the foundations of a building, resting upon a dark loamy clay, filled with water-worn pebbles, and covered with about six feet of strong coarse valley gravel.

Mr. Greenwell read the following notes, which were illustrated by diagrams :—

The impression of *Lepidodendron Sternbergii* now exhibited was found at Poynton, in the blue shale overlying the seam of coal called the "Accommodation Mine." When the props are drawn, a bed of shale, about four inches thick, immediately falls, and the plant was found in the lower surface of the shale lying above the bed.

No. 1.

The drawing, No. 1, is made from a portion of a plant (probably a *Sigillaria*) exposed in the band of the Accommodation seam at Poynton. The section of the seam at this point is as follows:—

ROOF BLUE SHALE GOOD.

	Ft.	In.
Good Coal	3	6
Band, Fireclay, not good	4	2
Bad Coal	0	9
Good Coal	1	5½
Black Shale	0	3½
Good Coal	3	1
	13	3

Fireclay Thill, coarse, with nodules of Ironstone.

The inclination of the strata here (300 yards west of the Nelson and 250 yards east of the Anson pit) is downwards to the west at the rate of 1 in 6, and the fragment of the plant is vertical to the planes of the stratification, and may therefore be assumed to be in the position, relatively to the strata, in which it grew.

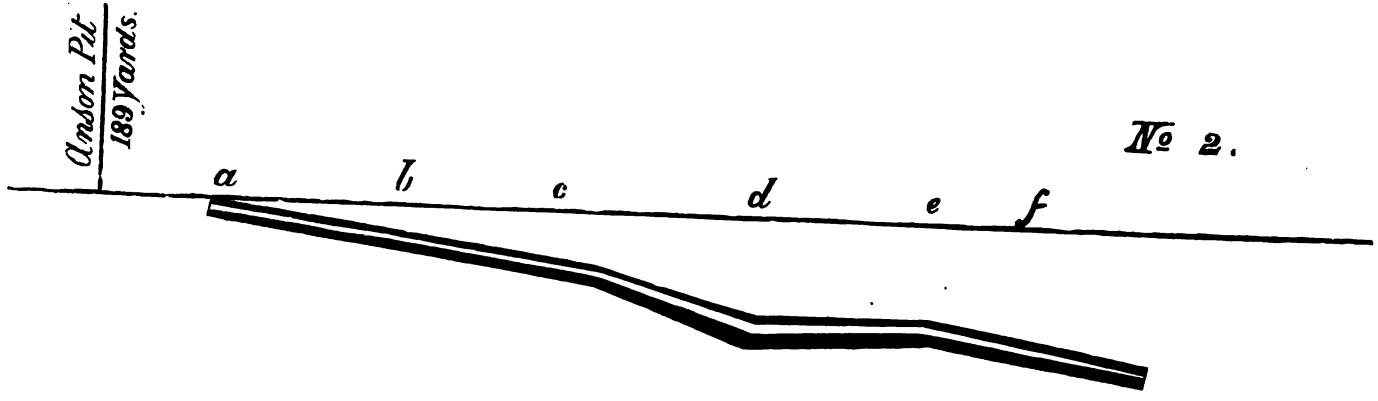
The length of stem mineralized is 3 feet 6 inches; its diameter is 20 inches; it is, excepting where the same has dropped off, surrounded by carbonized bark ¾ inch thick. It is under the bark vertically fluted with very shallow flutings 2 inches apart, and is covered also under the bark with innumerable small short striæ, which run horizontally. So far there is nothing remarkable about this fragment; what follows is, however, peculiar. Although the thickness of the band, as before stated, is 4 ft. 2 in., and the upper truncation of the plant is immediately under the top coal, and nearly flat, the lower truncation is rounded at about 8 inches above the underlying coal, and between the bottom of the truncation and the coal, is a neck of coal about 9 inches in diameter, which seems to be the carbonization of the entire tree between the truncation and the coal. This neck towards the coal again expands, as shewn in the drawing, and imperceptibly blends with the seam of coal.

Immediately under the neck is a portion of shale, also shewn in the drawing. At the top of the fragment the carbonized bark also appears to gather in, and blends with the top coal in the same manner as it does at the bottom.

It is not easy, I think, to arrive at any other conclusion than that the lower part of the fragment is the root end of the plant, and that the constitution of the root, and that of the bark, were alone capable of carbonization so long as surrounded by the clay, which now forms the band, but that above this, when the deposit was a vegetable one, the whole plant was capable of being carbonized, and was carbonized accordingly. We must either suppose this, or that all of the tree except its bark and roots perished, and and that the clay was deposited in the interior, as well as on the exterior of the plant, which is not very probable; and though improbable, it is difficult to account for the clay inside an any other supposition. The contraction of the plant at the roots is similar to that which we see in the *Calamites* and *Asterophyllites*, and leads to the conclusion that the fragment is one of a plant of this class.

That the deposit was a very gradual and gentle one is shewn by the two thin coaly partings which are interstratified with the band, and that the deposit did not take place simultaneously in the interior as well as on the exterior of the plant is almost asserted in this stone book, by the fact *that the coaly partings are not in the inside of the bark as well as on the outside.*

One conclusion we are, I think, led to, that it did not require such an immense mass of vegetation to produce our coal seams as has been generally supposed, for we clearly in this case have coal and vegetation bulk for bulk. If so, we do not need to go into the compression question; but the question fairly arises—*Was the wood of these ancient trees like that which we see now, and if so, what could be done to convert it bulk for bulk into coal?*



№ 2.

The drawing, No. 2, is a section of the Accommodation seam westward from the Anson pit at Poynton, already referred to. It is drawn to a natural scale, and shews in correct proportion a depression and thickening of the coal and band. The section of the seam at the level of the bottom of the Anson pit, "A," on the drawing is—

	Ft.	In.
Top Coal	3	2
Band	3	0
Bad Coal	0	9
Middle Coal	1	5½
Dirt	0	4
Bottom Coal	3	1
	11	9½

At B, 50 yards S. 69 W. of the last section, the depression is 20 feet, and the section is as follows:—

	Ft.	In.
Top Coal	3	0
Band	3	6
Bad Coal	0	9
Middle Coal	1	5½
Dirt	0	3
Bottom Coal	3	3
	12	2½

At C, 50 yards S. 69 W. of the last section, and just entering the swally, the depression is 41 feet, and the section is—

	Ft.	In.
Top Coal	3	9
Band	3	6
Bad Coal	0	9
Middle Coal	1	5½
Dirt	0	3
Bottom Coal	4	1
	13	9½

At D, 65 yards S. 69 W. (mag.) of the last section, and at the bottom of the swally, the depression is 68 feet 6 inches, and the sections—

	Ft.	In.
Top Coal	4	1
Band	5	3
Bad Coal	0	9
Middle Coal	1	10
Dirt	0	2½
Bottom Coal	5	4
	17	5½

At E, 45 yards S. 69 yards W. of the last section, and passing out of the swally, the depression is 64 feet, and the section is –

	Ft.	In.
Top Coal	3	8½
Band	3	7½
Bad Coal	0	9
Middle Coal	1	5½
Dirt	0	4
Bottom Coal	3	7
	13	5½

At F, 25 yards S. 69 W. of the last section, the depression is 66 feet 6 inches, and the section is—

	Ft.	In.
Top Coal	3	5
Band	3	6
Bad Coal	0	9
Middle Coal	1	5½
Dirt	0	4
Bottom Coal	3	3
	12	8½

Or about the usual section of this district of working.

The direction of the axis of the trough is N. 19 E. mag., and its breadth may be taken at 110 yards. We have here an instance of the process of depression (and we do not know when it commenced, as lower measures have not been exposed), continuing not only during the whole period of the formation of the coal and band of this mine, but afterwards, during the deposition of the shale forming the roof, unless the fact of the almost uniform thickness of the dirt, or black shale band, from 3 to 4 inches thick, may be taken as an indication, that during the period of its deposition, the depression was stayed.

The direction of this swally, or depression, is very nearly, if not exactly, parallel with the line of the red rock fault; but I think as the distance between the two is fully 800 yards, this can only be taken as a coincidence. I may mention that the line of section is nearly directly across or at right angles to the line of the depression, but the full dip of the measures at this place is 50° west of north. As to the causes of this and similar depressions I offer no theory, thinking as I do that the accumulation of facts is as yet comparatively meagre, and that it will be time to theorize when our store of such facts is complete.

The President—We are obliged to Mr. Greenwell and Mr. Aitken. This singular turn shown in the fossil tree is a thing I never saw previously. I should like to see the specimen before I gave an opinion upon it. The swelling out at the roots is a characteristic of all these trees. I have examined many hundreds, in all positions. This is a most excellent sample of specular coal; you nearly always find the bark converted into it. The trees in those days decomposed in the centre like modern trees. Plenty of trees now in moist situations decomposed till little more than the bark was left, and even in historic times, in some of those old British tumuli that are excavated, where oak branches have been placed for

the corpse to lie on, they are found with a sort of coaly matter on the outside of the bark, and inside there was nothing but clay. The Rev. Mr. Sibson, some years ago, investigated a barrow at Newton-in-Mackerfield, and the branches of oak there on which the body had lain, looked like pieces of wood, but when you laid hold of them they were full of clay—they were like a sausage, having a coating of carbonaceous matter on the outside, but full of clay. These fossil stems are usually filled with clay. There are other cases in which all the wood is petrified.

Mr. John Wild exhibited fossil palates of the *Ctenodus cristatus*, also the large ray of a fish *Ctenacanthus hybyoides*, all found in the roof of the Bent mine, Bardsley Colliery, near Ashton-under-Lyne.

The President said these were the finest specimens he had ever seen. Those from the Ardwick limestones, found many years ago, and described by Professor Agassiz, were not nearly so fine.

The thanks of the Society were voted to Messrs. Aitken, Greenwell, and Wild, for their contributions.

The following paper was then read :—

A FEW THOUGHTS ON

GEOLOGY, IN ITS RELATION TO ARCHÆOLOGY:

BY CHARLES HARDWICK.

Until within the last few years, antiquaries appear to have attached but little importance to the revelations of geological science. They seem to have regarded the whole of its teachings as

pertaining only to periods of time long anterior to the earliest era to which their enquires extended. Yet all history, or history in its widest acceptation, exhibits one continuous progress, from the building up of the inorganic structure, we term the earth's crust, to the developement of the human civilization of the present hour. The great facts pertaining to any one department of the philosophy or science which deals with the past, must, of necessity, often overlap each other; and, consequently, students in any artificial division of the historic domain can often render each other mutual valuable aid in their researches after truth.

My attention was first called to the importance of some sound geological knowledge to the antiquary, while engaged in the preparation of the "History of Preston and its Environs," some ten or twelve years ago, by the perusal of the following astounding paragraph, in vol. 4, page 293, of Edward Baines's History of Lancashire. Referring to the Saxon origin of the town of Preston, he says:—"When, by the gradual recession of the waters, or by that mighty convulsion of nature, which threw up the huge mass of Pendle, and deranged the whole system of plants and animals in the vale of the Ribble, to a great extent, Ribchester sunk into decay, Preston rose upon its ruins, and became the principal port of Lancashire!"

This was published as recently as 1836. The absurdity of ascribing even the most remote chronological relationship to the upheaving of the immense mass of millstone grit at Pendle, and the Roman occupation of Britain, can now only provoke a smile. But for some years afterwards gentlemen of reputation, both as geologists and archæologists, persisted in regarding Ribchester as a sea-port in the time of the Romans. Some, including the late Rev. John Clay, at one time contended that the upheaving of the rock in the valley of the Ribble, between that station and the sea, had destroyed the navigable channel. This theory found many advocates, notwithstanding the fact that the archæological evidence relied

upon was of a most unsatisfactory character. Dr. Leigh, in 1699, in conjunction with Mr. Oddy, of Blackburn, who had examined the remains found at Ribchester, decided that the anchor, &c., found there, from their relative insignificance, could only have belonged to the ferry boats attached to the station.

In 1855, whilst digging in the low mound situated at the confluence of the Darwen and Ribble, for remains of Cromwell's great victory in 1648, I was fortunate enough to meet with remains which demonstrated unmistakably that the site had not only been occupied by the Romans, but by the native Britons before their advent. Beneath the Roman glareæ I traced for about eight yards a foundation wall, eighteen inches in breadth, and nearly a foot in depth, formed of the soft new red sandstone which crops out at an angle in the river bed adjoining. As this lay *below* the Roman pavement, or gravelled stratum, and as no mortar had been employed in its construction, it was pronounced unanimously to be of British origin. It was embedded in a yellowish loamy clay, or till, which the workmen termed "sea-sludge." The Roman gravel was about a foot thick. It was covered generally by about two feet of river debris and vegetable mould. In some places, however, the gravel was nearer the surface. The Roman remains were very numerous, and varied in character. They included coins of the higher empire, which demonstrated that the place had been occupied by the troops of the conquerors simultaneously with Ribchester. This discovery of a second station on the banks of the Ribble demolished the ingenious philological theories of the two Whitakers, who sought, though in a strangely discordant and unsatisfactory manner, to fuse the Rigodunum of Ptolemy and the Coccium of the Itineraries into one and the same place. It did more; it furnished both archæological and geological evidence that the Ribchester sea-port hypothesis was untenable. The drift clay and river debris, in which the remains were found is stratified horizontally, and is "unconformable" to the new red sandstone on which it rests, and over which, and the carboniferous rocks above, the Ribble falls

considerably between Ribchester and Preston. And further, as I have elsewhere said, "if the tide had at the time referred to risen six feet higher, or, what would amount to precisely the same thing, had the level of the valley been depressed but six feet, the station at Walton could not have existed. Indeed it must have required *then*, as *now*, to be well embanked, to ensure protection against winter floods, even if the river current and tidal flow were no greater than they are at the present time." *

A striking instance of the value, and even necessity, of a combination of geological and archæological knowledge has been recently exhibited in connection with what has been described as the "Pre-Historic Man of Cheshire." In a Paper read before the Lancashire and Cheshire Historic Society, Sir Edward Cust states that this skeleton was found on the 22nd January, 1864, embedded in peat under a sandhill, which, within his own memory, was, he asserts, nearly 100 feet high. "The whole district about Leasowe Castle," he adds, "is sand based upon three or four feet of peat soil, which itself rests upon blue silt or clay." At a meeting of the Ethnological Society, on the 22nd of March, Professor Buck delivered a lecture on the remains, in which he observed that "the cranium was well formed, but there were some peculiarities in it which indicated an original race, or savage tribe." He added that "other skeletons had been found similarly situated in other parts of the country;" and suggested that "by the examination of their crania, it might be possible to distinguish the differences in the three tribes by whom Britain was occupied on the invasion of the Romans." Sir Edward refers to the fact that the hundred of Wirrall was an ancient forest until the reign of Edward the Third, and speaks of remains of the *Bos Primigenius*, *Cervus Elephas*, *Bos Longifrons*, &c., which have previously been exhumed from the neighbouring peat; and then adds,—"I am not aware, however, that a discovery has ever occurred of any memorial of primæval man's industry, either in stone or metal, in pottery or implements

* His: Preston and Its Environs, p. 24.

of war or the chase, in any portion of this extensive forest. Some writers of note have imagined that below the sandhills there has been an intervening bed of blue silt between two peat beds, and that shells, bones, and teeth of animals have been found in the upper of these, and Roman remains in the lower; and they have imagined a 'convergance of the strata' into one another at some stated points, by way of accounting for there being for the most part only one stratum of peat; *but this must be regarded as a mistaken account of the soil*, the nature of which will be found to pervade equally the entire district whenever it has been turned up by the plough, or has been exposed by the attacks of the sea, viz.:—1, sand; 2, peat; 3, blue silt, with boulders of various sizes; and 4, a strong impracticable red marl, almost of the consistency of stone."

Sir Edward, after referring to Dr. Hume's "Antiquities of the Sea Coast of Cheshire," says,—"Our learned friend is too modern for us by a great deal; his fibulæ, his tags, his straps and buckles, illustrate more civilized days. Our search is after Britons more ancient than even the—

'Pictos Britannos,
Hospitium ferox,'—

men of a time which must have been before the Roman invasion by land, or the Phœnicians by water." Indeed Sir Edward claims for his skeleton an antiquity long anterior to historic times.

Mr. H. Eckroyd Smith, on the reading of the Paper, protested against the hasty conclusions of its author, and declared that the skeleton was not found below, but several feet above the forest bog soil. He further asserted, from personal knowledge, that "the only peat beneath which it lay is a stratum only a few inches in thickness, composed of a residium of a comparatively recent marsh, and not of the ancient forest." In rejoinder, Sir Edward Cust published the depositions of the navvy who discovered the remains, the superintendent of works, and his gardener, as to the appear-

ance of the peat, &c. when the skeleton was found. They regard the stratum as pertaining to the lower or forest peat.

This is a most interesting subject for inquiry, and not a very difficult one, I should suppose, for practical demonstration, inasmuch as archæological remains of both the British, Anglo-Saxon, Mediæval, and relatively recent periods, abound in the neighbourhood. The real question at issue between Sir Edward Cust and Mr. Eckroyd Smith appears to rest on one important geological fact. If the statement of the former be correct, and the skeleton was deposited in a stratum which runs below that in which the Roman remains abound, it may, without impropriety, be described as pertaining to pre-historic times. But, if Mr. Smith's geological observations are to be relied on, then, unquestionably, the skeleton must be ascribed to a relatively very modern period. He gives drawings of two sections of the district, one at the east of the great Leasowe embankment, and the other on the west side of the "Dove marks." In both sections he shows the "lower forest peat," in which no relics of man or his works have been discovered; and the "upper forest peat," in which Saxon and Roman remains have been found, as well as "a few arrow heads, of flint, stone, and shell, in the lower portions thereof. A blue marl intervenes between these forest strata, with remains of *Bos Primigenius*, *Cervus Hybernicus*, and *Cetaceæ*. It, however, contains "no relics of man, save a few primeval flints." Above the "upper forest peat" is a stratum of blue marl or silt, in which "Saxon and Norman coins, and other objects" have been found. The stratum immediately above this, Mr. Smith says, is identical with that which yields mediæval remains, and in this the skeleton was discovered. Above the place of its deposit, in the Leasowe embankment section, are two thin layers of "peat destitute of trees," with an intervening stratum of "firm drift sand." In the Dove Mark section the upper peat or "marshy deposit" is exhibited, but in place of the lower, there is a thick layer of "artificial soil, cultivated evidently for many centuries." Mr. Smith, referring to

Dr. Hume's recent work, adds,—"It is an unfortunate circumstance that in *Ancient Meols*, this stratum is confounded by name with the lower beds of peat or forest bog, and a section (page 24) intended to illustrate the shore strata from Dove-point north-easterly, is, by some strange mistake, made to run landward, or from N.W. to S.E." As it will be no difficult matter to verify the truth or otherwise of Mr. Eckroyd Smith's sections, further geological inquiry will doubtless determine the question either in favour of that gentleman's view, that the skeleton was committed to the earth not more than five or six centuries ago, or it will demonstrate with precision to what period its interment ought to be ascribed.

On digging into the "Castle Hill," at Penwortham, near Preston, in 1856, the "stratification" of the mound presented some features which greatly puzzled both the geologists and archæologists assembled. It was generally granted that the sandy loam and vegetable soil, which covered the boulder pavement at E, on the accompanying drawing, which I made at the time, was recent, and partially the work of man. Not so, however, with the lower strata, numbered 3, 4, and 5, which were formed respectively of loamy clay, red sand, and a wet sand resembling quicksand. This, it was stoutly contended by some, was of aqueous origin; that it pertained, geologically, to the glacial drift period, and that, consequently, all further downward search for evidences of human occupation must of necessity prove fruitless. Nevertheless, we continued excavating, and were ultimately rewarded by the discovery of the prostrate remains of a wooden building, with a boulder pavement and a wattled roof, and several archœological remains in iron, bronze, lead, wood, stone, even leather, which demonstrated that the human occupancy had been, at least, as recent as the Roman dominion in Britain. These remains were deposited at from twelve to fourteen feet beneath the earth's surface, and were in excellent preservation, in consequence of their being buried in company with a large quantity of the bones of animals, which formed the ordinary food of the inhabitants during the Roman and Anglo-Saxon periods of

our history. My own impression is, after much consideration, that the building was a kind of stockade, a *specula* or look-out, in connection with the Roman station previously referred to, near the junction of the Ribble and Darwen, at Walton; that it had been destroyed by the "barbarians" on the departure of the Roman legions, and that the mound had been heaped upon the ruins afterwards, and formed into a "mote hill," or open-air court of justice, during the Anglo-Saxon period, in connection with the King's Castle, mentioned in the Domesday survey. Nevertheless, many believe to this day that the mound was a naturally formed hill, and that the inhabitants of the subterranean edifice were cave-men, or earth-men, of a very remote period, and that they entered their dwelling by an opening in the hill side. I may add that the mound stands on the naze of the promontory overlooking the tidal estuary of the Ribble, near to Penwortham church, and is from thirty to forty feet above the alluvial plain through which the river winds its course to the sea.

Another instance, within my own experience, has recently occurred, which demonstrates the value of a union of archæological and geological experience when examining remains of the "recent" period of the world's history. Not long ago I visited the Craven district of Yorkshire, in the company of a party of gentlemen who had organized a "geological excursion," with the view of adding something to my very limited practical knowledge of this science. During our sojourn I was shewn the interesting and valuable collection of cave relics found in the neighbourhood of Settle, in the possession of Mr. Jackson. A single glance assured me that the great majority pertained to the period of the Roman occupation of Britain. On some geologists and ethnologists present expressing their surprise at my confidence in the matter, I made a more detailed examination of the remains, and found amongst them several Roman bronze coins, which could easily be recognized as such by an archæologist, at sight, without the necessity of

determining the name of the individual Emperor whose head was faintly recognizable, notwithstanding the oxidation of the copper.

I was given to understand that these remains were found embedded in clay, and that the said clay could not have been washed into the caves from above, as no such deposit was there to be found. Some contended that the clay belonged to the glacial drift period, and that the remains must have been deposited thereon or therein at a very remote period. Indeed, I understand, that one gentleman present still retains some such opinion, and expresses his conviction yet, when lecturing on the subject of ethnology, that these remains, as demonstrated by the geological facts attendant upon their deposition, must have belonged to the earliest inhabitants of the island. One gentleman, perfectly satisfied that the remains, as I had stated, belonged to a period at least a couple of centuries later than the commencement of the Christian era, and anxious to explain away the "geological difficulty," suggested the possibility of the clay having been gradually carried into the caves from the valley below on the feet of the parties who resided therein. This certainly very ingenious theory is, I think, however, not necessary to solve the difficulty. From the number of articles which pertain to females, their children, and the domestic labour of the period, I am inclined to think the most probable solution is that the caves were used as places of concealment by the Romano-British inhabitants during troublesome times; and that the clay was taken into the caves by them, in order to make a level and dry flooring. This is no mere conjecture, inasmuch as some such provision would be necessary to render the habitations even tolerable to relatively civilized people; and the practice of making floors of clay is still well known amongst the peasantry in remote parts of the kingdom, and even in Lancashire and Yorkshire at the present day. The practice likewise obtained at the earliest periods, concerning which either historical documents or archæological remains enable us to speak authoritatively on the subject.

I have purposely confined my observations to matters of which I have some personal knowledge, and which have a local as well as a general interest, believing that by so doing I should best consult the objects of the Manchester Geological Society, and the wishes of its members. The questions raised by the contents of the Danish peat mosses, and "kitchen-middens;" the lacustrine dwellings of various countries; the river gravels of such valleys as the Somme, near Abbeville, and the Ouse, near Bedford; the caves of Dusseldorf, Liege, Brixham, &c., where human remains have been found in such connection with those of extinct mammalia as to justify the belief in their very remote antiquity, are too momentous for a mere passing allusion at the conclusion of a Paper like this. My chief object has been to show that the local geologist and archæologist can be of mutual service to each other. I wished likewise to express my obligations, as a student of the latter, to several members of this Society for many valuable practical hints.

There is one element in enquiries of this class, which it is incumbent on all to cultivate, and that is the careful observance of all the facts or phenomena pertaining to any given investigation, and their faithful recordation, without reference to their bearings upon any hypothesis or theory whatever. The substantial progress of all knowledge is based upon this course of procedure. All true science is but the expression of laws, the uniformity of which have been discovered, by the analysis of numerous individual phenomena. Care is especially demanded in the examination of recent river deposits, in consequence of the apparently eccentric nature of the changes which have and are continually taking place. It is not imperative, to my mind, because early flint implements have been found *amongst*, or even *beneath*, gravels containing the remains of such extinct animals as the *Elephas primigenius*, or the *Rhinoceros tichorhinus*, that we should at once infer that man existed either antecedent to or contemporaneous with those mammalia. That man existed before the time of the deposition of the gravels in their present locations may be most certainly relied upon, and, in the

cases of such as those near Bedford, Abbeville, and other well known sites, the antiquity *thus* demonstrated is too remote to be satisfactorily described by chronological figures. But it is not impossible, notwithstanding their present conjunction, that the mammalia referred to may have existed long anterior to man, and have left their bones in the earth centuries before his advent. The debris of the first human occupants of a given locality may have lain above those of the extinct mammals for a considerable period. The abrasion of this land by after fluvial action would denude it, in the first instance, of its latest deposits, and would lay the debris in such a position that succeeding abrasion would result in the deposition of the older strata, with its remains of long extinct animals, *over* the earlier, which included the human flint implements; or a general conglomeration in some cases would doubtless result. The Ribble has torn away a considerable portion of the bank occupied by the Roman station at Ribchester within relatively recent times, and deposited its *detritus* lower down the stream. I should, therefore, feel no surprise at the discovery of Roman remains in such a locality overlying others of unquestionable Saxon or Norman date. Within my own memory, owing to the action of a couple of jetties, an island named the "Holme," below Penwortham church, near Preston, has been joined to the south bank of the Ribble. Vast quantities of debris, brought from above by floods, have been deposited within the last fifty years. The old channel is now obliterated, or nearly so. A change in the direction of the current, sufficient to cause denudation of the low mound at Walton (which I have seen under water more than once), would have deposited Roman remains over others as recent as the present century. Of course these instances are given merely to illustrate a principle; but it is a principle of vast importance, and of very extensive practical application.

The thanks of the Society were voted to Mr. Hardwick for his paper.

Mr. Aitken—On the occasion referred to by Mr. Hardwick, when a number of gentlemen from this part of Lancashire principally, visited Settle for the purpose of examining the geological features of that district, I happened to be one of the party, and of course went over the district. It was my first visit there, and I was very much pleased with it. But I was in the district where these cave relics have been most numerously found, I believe, in the higher part of the hills overlooking Settle, and, so far as I remember there is no clay to be found in that neighbourhood. I am quite open to correction; but if that be so, the difficulty presents itself how this clay should have been taken into its caves on the principle suggested by Mr. Hardwick. If no clay exists in the neighbourhood, it is not at all likely the inhabitants who made use of this cave would fetch it from a long distance, as the soil and *debris* of the rocks, which are limestone in that district, would have been sufficient by being pounded and carried in, to be made serviceable. I should like to ask therefore, does any clay exist in that neighbourhood?

Mr. Hardwick—My friend Mr. Chattwood was one who heard the discussion about the clay. It is found in the valley below, and it was contended that it might have been taken up into the caves upon the shoes of the people.

Mr. Aitken—There is clay if you pass the Great Craven Fault, and go into the millstone grit formation, but I think none on the mountain limestone formation; and that must be a very considerable distance—perhaps some mile and a half from the cave. But soil is found in abundance near.

Mr. Chattwood—But you can't make serviceable floors of the soil.

The President—I think it is very possible that the remains found in the caves near Settle,—I believe it is Mr. Jackson's collection? (Mr. Hardwick assented)—may be remains of very

different ages. When people remove anything at the bottom of the cave they should do the same as navvies do with their excavations—they should leave pillars, to show what has been removed. In that cave there might be deposits of a very modern period of time, for instance in the time of the Saxons, when people might have taken refuge in those caves; and again, of the time of the Romans, and of the time of the old Britons, and there may have been also remains of some pre-historic men. Without you carefully go from the top of the cave deposit to the bottom, and leave some indications sufficient to show what you have taken out, very often a man may dig wheelbarrows full, and remove them, and you can't tell what came first or last. The great value of all investigations of this sort is that they should be very carefully done at the time they are first discovered. I certainly think with Mr. Hardwick, from what I saw of the collection, that a great many of the specimens were of no greater date than the Roman age, probably the Lower Empire would be fully as late as they were; so that in fact it is for the most part a very fine collection of Roman antiquities. With regard to what this gentleman speaks about Leasowe, it is a very complicated question, and requires a great deal of hesitation before one can say which of two learned archæologists is right; but as to seeing a bed of peat with 50 feet of sand over it, that might be a thing of yesterday. Sand hills shift so very fast that there might be 40 or 50 feet accumulated over a bed of peat in a very few years. I think Dr. Hume says he doubts whether there are several beds of peat; there are certainly two on the Lancashire side, and I don't see why there should not be two on the Cheshire side. What Mr. Hardwick says about these places, where remains of extinct animals, and remains of human implements are found, that the animals may have been of much greater age than the implements, that proves probably too much, because the men who made the implements might also have lived very early as well as the animals. I should like the members to pay attention to the high-level gravels in our own neighbourhood. I think from what Mr. Hardwick says, that the remains found near Penwortham are certain-

ly of a modern period when compared with anything we should expect to find in the high-level gravels. Take for instance the remains found at Castle-Field some years ago, unquestionably there was an old house, with its pavement under the Roman Mancunium. If any gentleman would carefully look at these high-level gravels in the valleys of the Irwell, Mersey, Dee, or Lune, we might find some remains similar to those found in France, and also in the valley of the Ouse in our own country.

Mr. Hardwick—My friend Mr. Aitken has perhaps misunderstood me. I don't tell you with certainty how the clay got into the cave, but I object to geologists telling me it is glacial drift-clay, and that therefore the remains must belong to a certain period. I say these coins must decide the date of the clay. I don't say how the clay got in. You must not tell me, because you find old drift clay, you can tell me the date of the remains. I have given you the best help I can. I fully believe the people would go more than a mile to get clay for these caves, before they could live in them. At the present day, some of our farm-house floors are made of clay and nothing else. Common loam won't do. It is a vast deal more probable than that Roman coins should be found among drift clay. With regard to the other point, the over depositions of the older remains, I say again, as I said in the paper, I don't feel certain, because we find in the river gravels a certain quantity of implements that they are necessarily as old as the accompanying remains. I believe the remains now shown by Mons. de Perthes, and Mr. Wyatt, of Bedford, and others, really are the work of man. I don't consider, because we find them in those gravels, that the men who made them of necessity existed at the time the mammalia we refer to existed, because the gravels are evidently the result of alluvial action, that must have denuded some land previously, and the first denuded would be the latest remains, and they would lie lower on their redeposition than those denuded afterwards. But the date of these river deposits themselves is so great that we cannot form any idea of the time. But my chief object is, that in our

present enquiries we should be careful when examining in our local rivers, to ascertain whether the drift may not have been deposited at a relatively recent date, because, as the President once remarked about some place near Collyhurst, changes take place in the little deposits on river sides within a very short period indeed. Near Preston I can remember in my boyish days there was a great island in the Ribble, and I recollect seeing vessels at the foot of Penwortham Brow; it was two islands in the last century, but now the gap is filled up entirely by detritus from above. Provided the mound at Walton had been eroded, and as there are two streams, the Ribble and the Darwen, the least change would do it, it would deposit the Roman remains which it contains over others which pertain to the present century. Therefore the mere finding of remains superimposed does not necessarily demonstrate that those below are the older.

Mr. Plant—We must be very much obliged to Mr. Hardwick for introducing a subject not usually considered as belonging to the Geological Society. There is no doubt whatever that there will be a closer approach between archæology and geology, as the two sciences approach nearer to that point in time where they are to meet; but I don't think there will be any of the difficulties Mr. Hardwick seems to fear. If the student of archæology thoroughly understands his own subject, he will be able to detect readily, even in fragments, the handiwork of man, under all circumstances, especially those that have association with historical peoples like the Celts and the ancient Britons. No archæologist would hesitate for a moment to pronounce to which of those peoples certain of the remains belong. But here is an illustration given of the finding of the skeleton of a man in the peat-bed of Leasowes, which is a very different question, and one always likely to raise a considerable amount of diverse opinion. A skeleton is not exactly stamped with the same impress as a piece of Roman pottery is, and would not be so readily recognized; and there is no wonder that Sir Edward

Cust should have mistaken it for a pre-Adamite man. But some other writers in the locality, who seem to have been well aware of what the subject was, wrote some doggrel rhymes, in which it was proved undoubtedly that the man was a poor shipwrecked sailor; and although the remains were said to be divested of clothing, there was found some coin of no very ancient date. I don't think that any other objects would ever be mistaken either with regard to the people they belonged to, or the period they should be ascribed to. We seem to be approaching nearer the time when we understand the researches so carefully conducted by the leading men, and there is no longer the hesitation there was some time ago in pronouncing on these matters, geological or archæological. I agree with the President, that the examination of these high level gravels is a work that has never yet produced here what it ought to do, and what every other locality in Britain seems to turn up, and what is the case in France, at least, where we find the animals that existed at the time of the deposition of these gravels. It seems at present as if the western side of the Penine chain of hills were totally barren of those beautiful objects connected with animal remains, and shells, which are so plentiful in the southern part of the island; because we don't class the glacial drift shells at Macclesfield, Southport, and elsewhere, as belonging to this period. The whole of this high level valley gravel period in Lancashire is so far destitute of objects belonging to animal and vegetable life, or even the life of pre-historic man.

The President—I think the crannoge found at Castle Field, is better evidence than any stone or other implement.

Mr. Plant—Crannoge is a purely local Irish term, and no one has ever yet affixed a date to it.

The President—But there is not the slightest doubt about the date. It is as old as any of those gravels of the Somme or any

place you can find. We adopted the term because archæologists and geologists have taken it. It was found here some 40 years ago, when there was no idea of its importance—it was before there was any *odium theologicum* imported into the question. With regard to the drift found near Settle—call it glacial drift, or any other drift—but produce a good greenstone or other foreign pebble, duly striated, that is what you have to find, not a mere bed of clay, before you call it glacial. Men may be found in peat, who have been buried, say in Chat Moss, 50 years ago. There are peat bogs, to my own knowledge, where I have seen Roman remains taken from under deposits of nearly 20 feet thick, which seemed undisturbed. The level of Hatfield Chace was a fine forest in the time of the Romans. It was simply by the level of the Ouse and the Trent being raised and their beds silted up, so that the drainage of the country was impeded, the water was thrown back on the lands, the trees were killed, and the bog was caused.

Mr. Plant—Let me state what appears to have been a misapprehension on my part; I thought you meant us to infer that the crannoge stood there at the time the high level gravel was deposited.

The President—I have no doubt about it.

Mr. Plant—Then I must beg your pardon. There are no crannoges in these islands, supposed to be as old as the islands themselves, because they are uniformly, without exception, dug into the mud like cellars, so that the structure is not built upon the land: and if this was found in the gravels at Knott Mill, and did belong to the same age as the Irish crannoges, there is no doubt whatever that its construction was carried out in the same manner, so that the age of the crannoge and the deposition of the valley gravel does not by any means follow.

The President—I have nothing to say about Irish crannoge; I simply state a fact connected with valley gravels. I only use the

term; I say nothing about the age. I merely said, in relation to what Mr. Hardwick spoke about on the Ouse and the Somme, that there were found here evidences just as valuable as any found there. What I name a crannoge was a house, with a paved floor: I don't care what it is called, but it was found there, under the Roman encampment; and I mention it for other people to see if they cannot find other remains like it. I did not see it found myself; it was found before I came to Manchester, but the evidence given by the late Mr. F. Looney, F.G.S., is unimpeachable.

The meeting then terminated.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 14.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, February 27th, 1866.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

The President exhibited some remarkable fossil plants found in beds of volcanic ash, in the lower part of the Scotch coal measures at Laggan Bay, in the north-east part of the Isle of Arran. These specimens, which consisted of *Sigillaria*, *Lepidodendron*, *Halonia*, *Lepidostrobus*, *Antholithes*, and other plants, were discovered by Mr. Wunsch, Vice-President of the Glasgow Geological Society, during the last summer. They have been described in papers read at the geological societies of Glasgow and Edinburgh, by Mr. Wunsch and his colleague, Mr. John Young, of the Hunterian Museum, Glasgow, so well known for his labours in the Scotch coal-fields. The fossils afford structure in most of their parts, and have evidently grown on the spots where they are now found. The large stems rest on thin beds of coal or dark coloured shale, and have become anthracitic by the action of heat, and are surrounded by volcanic ash. There have been four or five distinct beds, one over the other,

seen. The deposit in which they were found would pass for trap or whinstone, and it has been described by geologists as such. Fossil shells had been met with in Derbyshire toadstone and interstratified trap, but he had never before heard of fossil plants being found in such deposits, until the discoveries of Mr. Wunsch. Rival schools of geologists had been too much accustomed to attribute the origin of strata to their own favourite cause; the Wernerians being too apt to trace nearly every thing to aqueous action, whilst the Huttonians are equally bigoted in bringing igneous action to prove their own positions. The fossil trees in question no doubt grew in a marine *habitat*, and were enveloped with ash thrown out by some neighbouring volcano into the sea, and afterwards deposited around them, just as we often find similar trees in our coal-fields enveloped in shale or sandstone, water carrying the material forming the matrix in each case. In the Laggan specimens we thus have proof that both fire and water were in operation to account for the phenomena there observed. It was rather singular that a countryman of Werner should come to Scotland, the stronghold of the Huttonians, and find in their own country a rock where they would have claimed as plutonic, full of the remains of plants in the position where they grew. The specimens on the table came from Mr. Wunsch's collection.

The following paper was then read, by Mr. Plant:—

THE GEOLOGY AND FOSSILS OF THE

LINGULA FLAGS, OR PRIMORDIAL ZONE,

OF THE GOLD DISTRICTS OF NORTH WALES.

BY

JOHN PLANT, F.G.S., AND EZEKIEL WILLIAMSON.

The object of the present communication to the Society is briefly to announce several interesting discoveries, which were

made by Mr. Ezekiel Williamson, in the autumn of 1865, in the well-known gold bearing district of Tyddynglwadis, lying eight miles to the north of Dolgelly, on the upper valley of the river Mawddach, in Merionethshire, North Wales.

The Society will remember a former communication upon the *Paradoxides Davidis*, but the present discoveries possess a much wider interest to those who make the strata lying at the base of the Lower Silurians the principal object of study, for they establish for the *first time*, in this locality, an almost complete similarity of stratification and mineral characters in the rocks, and a sufficient identity in the palæontology, to relate them with their equivalents, the "Zone Primordiale," of M. Barrande, in Bohemia; the "Regiones B and A," of Angelin, in Scandinavia; the "Potsdam Sandstone," of Hall and Bigsby, in the United States; and the "Primal Group," of Sir W. Logan, and Professor Rogers, in Canada.

To the members of the Manchester Geological Society, it should have a special interest, lying as it does, in a locality famed for its bold mountain scenery, its waterfalls and attractive features, all easily accessible in a few hours by rail from Manchester.

It would not be incorrect, to state that this locality has been subject to many very scientific and careful geological explorations during the last thirty years; and what is more remarkable, that the lower and middle portions of the strata have been actually honeycombed with shafts and adits, excavated in the search for gold and silver veins, and yet its true fossiliferous character—with the few exceptions to be named—escaped the vigilant eyes and active hammers of the eminent geologists of the Government Geological Survey, as well as of the managers of the mines, with their corps of assayers, mineralogists, and geologists, whose reports,

from their erudition and extent, would seem to have left nothing undescribed of the physical features of the strata, from the surface to a depth of 40 fathoms below.

It is not necessary to mention any but the principal of the printed memoirs relating to this locality, as in the works of nearly all our leading writers on the geology of Great Britain, the North Wales gold district is generally described and included in either the Upper Cambrian or Lingula Flag series. The prominent labours of Sir R. I. Murchison more than thirty years ago, in South and North Wales, resulted in the establishment of the Silurian system, and on the publication of his great work in 1837, these slates and altered rocks were described as unfossiliferous slates, forming the base of the Lower Silurian formation. Afterwards Professor Sedgwick devoted his masterly attention to the geology of North Wales, and he described them as an Upper Cambrian formation; and this view is at present held by Sir Charles Lyell, Professor Phillips, Professor Jukes, and other leading geologists.

In 1842 the locality was explored by Mr. Daniel Sharpe, who described and mapped the rocks as belonging to the Lower Cambrian series.

In 1845 Mr. J. E. Davies described the geology near Tremadoc, and discovered the species of *Lingula*, which was afterwards adopted by Professor Sedgwick in the designation of the rocks immediately overlying the Cambrian Grits, in North Wales, and subsequently the strata overlying the Cambrian Grits became known as the *Lingula Flag* beds.

In 1854 the map and sections of this district were published by the Geological Survey, and the strata are thereon stated to be "Lingula beds;" "dark slates, sometimes ferruginous, and banded arenaceous flags, often much altered, especially on Moel Hafod

Owen; greenstone, probably continuous beneath, breaks through in places in the neighbourhood; (in the section No. 37, is seen a single bed of greenstone capping the hill at Tyddyngwladis,) and the fossils found in the locality are mentioned as *Lingula Davisii* abundantly; *Olenus micrurus* and *Hymenocaris vermicauda* more rarely." Professor Ramsay republished a memoir on the physical structure of Merionethshire, in 1858, giving a very interesting general description of the geological features of the gold mining district, and of the locality near Tyddyngwladis, which agrees with the map and section of the Survey.

In 1860 Mr. T. A. Readwin, F.G.S., read a paper to this Society on the "Gold discoveries in North Wales," describing the strata as "Lingula Flags, slaty, more or less arenaceous, interstratified with courses of sandstone, all frequently penetrated by light grey calcareous and ordinary greenstone dykes, some of which are magnetic, and that the district is palæontologically barren."

In May, 1864, Mr. Readwin found the first specimen of *Paradoxides Davidis*, and in a paper read by myself to the Society, at the end of the year, the geology of the locality was explained by a section as far up as the Cwmheisian Flags, considered to be Lower Lingula beds; and the discovery of the fossils *Theca*, *Anopolenus*, and *Paradoxides*, in the lowest series of slates, then announced, was regarded as sufficient to establish for these slates a distinct primordial character from those higher beds in which were found the *Olenus* and *Lingula* described by the Survey. These recent discoveries prove the correctness of this view.

In the autumn of 1864 Mr. Readwin commissioned Mr. J. W. Salter, the eminent Palæontologist, to survey the gold district on the river Mawddach, and map out the faults, dykes, and mineral veins; and in the "Notes to accompany the Map of the Faults," published by Mr. Readwin, December, 1865, the result of this last scientific exploration of a locality, so frequently described before,

appears to consist, in the recognition of strata overlying the Cambrian Grits, as belonging to the *lower* and *middle* divisions of the Lingula Flags, already known in other places in North and South Wales; taking as a base the line of division between the Lower Cambrians and overlying strata, most accurately laid down in map 75, N.E. and S.E. of the Geological Survey, the following ascending series of strata are described in the "Notes," viz:—

Lingula Flags	Lower division	*a.* Cambrian Grits.
		b. Cambrian black shales.
		c. Mawddach hornstones.
		d. Cwmheisian flags.
		e. Dolfrwynog beds.
		f. Llanelyd slates.
	Middle div.	Hard sandstones of Cefn Mawr and Moel Hafod Owen.

The only one fossil found in the rocks by Mr. Salter, in this [illegible] examination, was fragments of Trilobites, (probably [illegible]) in the Llanelyd slate. *Lingula Davisii*, the common fossil, and *Hymenocaris vermicaudis*, the rarer fossil, of the Geological Survey, are only mentioned as belonging to the Middle Lingula Flags, but are not stated to have been found. To complete the consecutive narrative of the progress of discovery, it ought to be added that Mr. Williamson returned to the gold mines in June, 1865, determined to try the soundness of an opinion which we had often discussed, viz: that the strata in the locality of Tyddyngwindle, within a limited range eastward, from the boundary line of the Lower Cambrian Grits, ought to yield a complete series of fossils of the primordial types. During the summer of 1865 the search was commenced upon a systematic plan, in the autumn I (Mr. Plant) was able to spend a short time examining and work-

ing over the district, and Mr. Thomas Belt, of the Prince of Wales mines, rendered assistance searching in the slates for fossils; Mr. Williamson, at the same time, working out a section over the ground, and laying down the beds included in the districts from whence the fossils were collected. The work was brought to a close at Christmas, and the collection came under my examination for developing and naming.

The section of the strata exhibited extends about four miles from the line of junction of the Lower and Upper Cambrians at Cefn Ddiddwr, to the base of Craig-y-Dinas on the east; the ground worked over is not in a continuously straight line, but made up of four runs, a little to the north of each other. The first part comprises the slates and traps seen in the Tyddynwladis silver lead mine shaft and adits to the bed of the river below. The second part commences at the turbine engine, Cwmheisian, just beyond the Mawddach waterfall, and runs S.E.E. to Hafod-ffraith. The third part commences about a mile higher up the Mawddach, at Bryn-y-garth-isaf, and runs S.E.E. by Hendre-berfedd to a confluent of the Mawddach called the Afon-Geirw. The fourth part commences still higher up the river Mawddach, south of Craig-y-Dinas, and runs S.S.E. to Rhobell-y-big. This diversion was rendered necessary to obtain a clear outcrop of the beds, the flanks of the hills being in many places covered with drift matter, and also, to avoid uncertainties and disturbances from trappean masses, which a straight line of any length is certain to meet with in the gold bearing strata; however, the correlation of the strata in the section is just as certain to be correct, the base of each portion being correctly traced, overlying beds belonging to lower divisions.

For convenience of identification in further labours in this locality, it has been considered that the beds should be numbered and designated, as far as possible, by names of the places where the fossils occur, a view which is carried out in the following grouping:—

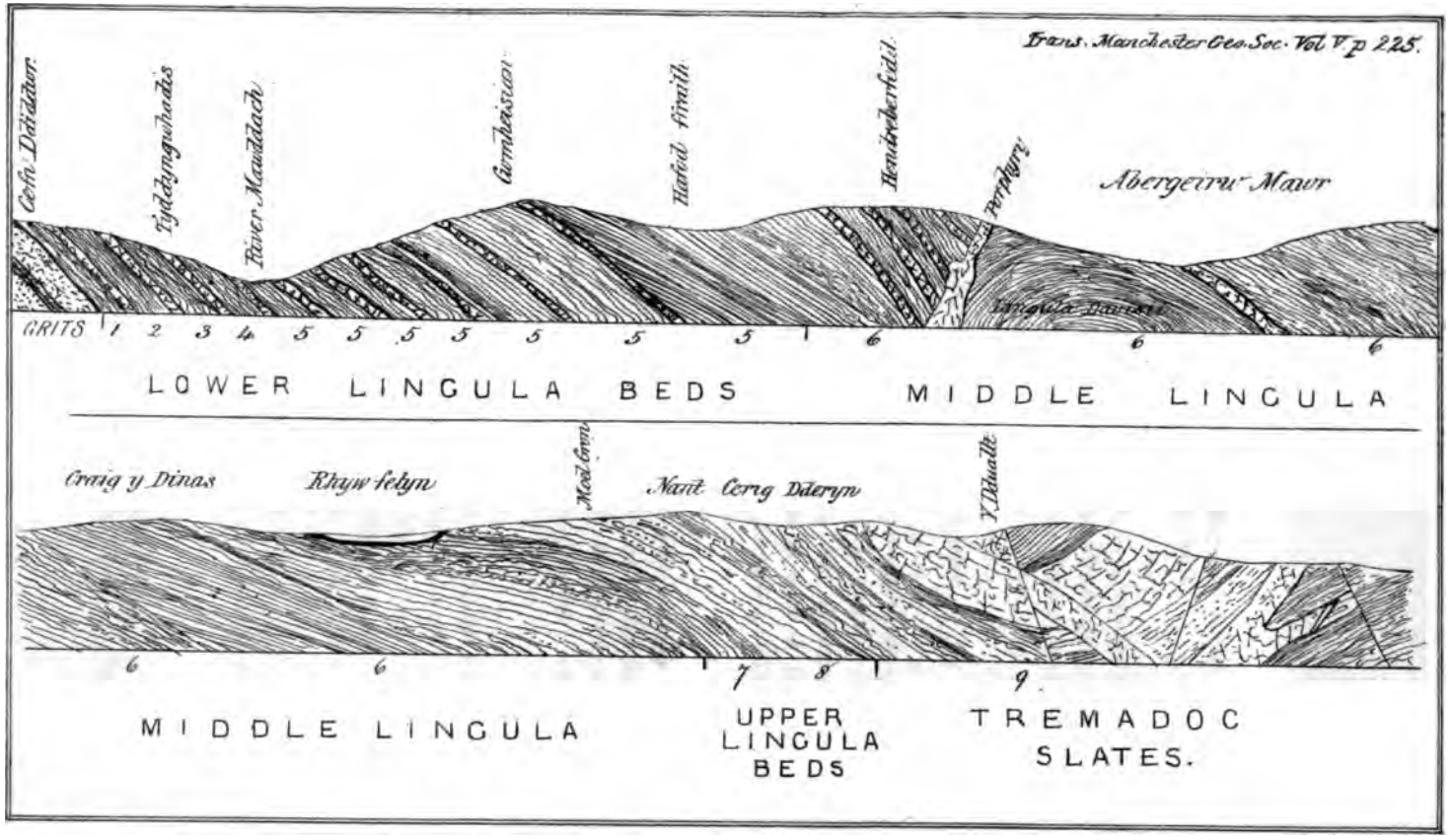
LOWER CAMBRIAN, OR HARLECH GRITS.

			FEET.
Upper Cambrians Lingula Flags Primordial Zone	Lower Lingula Beds.	Nos. 1 & 4—Tyddyngwladis slates and interbedded traps.....	1136
		No. 5 — Cwmheisian flag series of felspathic traps and grits..... about...	1500
Upper Cambrians Lingula Flags Primordial Zone	Middle Lingula Beds.	No. 6—Hafod Owen, thick bedded & banded felspathic sandstones, a few beds of trap..... about...	4000
Upper Cambrians Lingula Flags Primordial Zone	Upper Lingula Beds.	No. 7—Rhyw Ffely, black slates & shales	750
		No. 8 — Moel Gron, slates and shales ...	750
		No. 9 — Tremadoc slates, not examined	

It being practically impossible to measure the beds in each division exactly, on account of faults and broken ground, these measurements are only to be considered approximative.

The four slates with the intervening traps, Nos. 1 and 4, have already been described in the paper upon the *Paradoxides Davidis*. It need only be added that, as the base of the series of strata of the Lingula flags, they appear to be very consistent, the section at Ffestiniog, north of the great Merioneth anticlinal, exhibiting the same identical arrangement of slates and traps. We may also say, that these slates form the *Menevian group* originated by Mr. Salter, for similar beds at St David's, South Wales.

The fossils of these beds are very interesting, showing the primal forms of Mollusca, Crustaceans, and Sponges, discovered in the lowest fossiliferous zone of the geological formations.


Trans. Manchester Geo. Soc. Vol V p 225.
Cefn Ddiddwr
Tyddyngwhadis
River Mawddach
Gwmheisian
Hafod firaith
Hendreberfeldd
Porphyry
Abergeirw Mawr
Lingula Davisii
GRITS 1 2 3 4 5 5 5 5 5 5 5 6 6 6
LOWER LINGULA BEDS
MIDDLE LINGULA
Craig y Dinas
Rhyw felyn
Mod Gwm
Nant Cerig Dderyn
Y Ddualt
6 6 7 8 9
MIDDLE LINGULA
UPPER LINGULA BEDS
TREMADOC SLATES.

LOWER LINGULA.—TYDDYNGWLADIS SLATES.—No. 1 bed of slate has not been worked, but probably contains fossils.

No. 2 slate has been examined by Mr. Belt, in the bed of the river Camlan, about three miles south of the section, who found specimens of *Paradoxides Forchhammeri*, *Anopolenus Henrici* (Salter), and another species; *Agnostus*, two species; *Protospongia*, *Theca*, and a small attenuated *Lingula*, *Obolus*, *Obelella*, and *Leperdita*. At Tyddyngwladis was found *Paradoxides*, *Anopolenus* and *Theca*.

In No. 3 slate the fossils are *Obelella*, probably two species; *Obolus*, *Theca*, *Lingula*, *Protospongia*, and a twisted cord-like *Zoophyte*; *Obolus* is like *Obolus appollinus* of the Potsdam sandstone, figured by Dana; and the *Obelella* like *O. nana* of the same formation and author; *Agnostus rex*, *princeps*, *pisiformis*, and *trisectus*, *Microdiscus*, and *Anopolenus* have also been found.

No. 4 slate has yielded the great *Paradoxides Davidis* in profusion. We have parts of 122 different specimens; the head and the tail are found but seldom. This fossil is confined to a narrow band of the slate and does not occur throughout; with it have been found a few *Theca*.

No. 5. CWMHEISIAN FLAGS.—Consisting of a series of hard grey striped slates, waxy felspar grits and interbedded traps. In the upper part of this series is a thick mass of black slate containing *Olenus cataractes*, *Agnostus princeps*, in abundance, but all the *Agnosti* are smaller than in the preceding beds. Other fossils are *Sao hirsuta*, and species of Trilobites not named; a small Petraia, a new Bryozoon, of pretty form, and tracks of crustacean. It may be mentioned, that the lowest part of these slates are unfossiliferous.

MIDDLE LINGULA.—No. 6, HAFOD OWEN FELSPATHIC SANDSTONES AND TRAPS.—This is the thickest part of the whole section, and

might well be separated into an upper and a lower division; the latter, consisting of banded felspathic sandstone, is remarkable for a bed of muddy dull rock in the middle, the bedded surfaces of which are covered with annelid trails and other sea bottom markings. The upper part is the fossiliferous part, of similar character of rocks, which gradually merge into the shales and slates of the overlying division, No. 7.

The fossils of this division are the well known *Lingulella Davisii*, found most abundantly, assuming the appearances of many different species, from the various forms it is changed into by pressure in the strata; with this occur, in the top beds, a few Trilobites of the genera *Olenus*, *Conocoryphe*, a fucus of the American genus *Buthotrephis*, found at Penmaen Pool, and impressions of a Gorgonia.

Upper Lingula. — No. 7. Rhyw-feln Slates and Shales.— This is the narrowest part of the series, consisting of black slates and thin shales, much broken and contorted. The most conspicuous fossils are a small new *Orthis*, and a new shell (perhaps *Orthonota*). These two shells abound in beds of dark blue slates; the shells are yellow from peroxide of iron, and are much compressed, often lying so thickly strewn on the bedding as to give it a roughened surface. A *Lingula*, differing from *L. Davisii*. The trilobites are plentiful, both in species and number, a new *Olenus* with hair spines to the pleuræ *Olenus spinulosus*. (Decades xi. pl. 8. fig. 16), *Olenus bisulcatus*, *humilis*, *pecten*, *alatus*, and several species of *Agnostus*.

No. 8. Moel Gron Slates and Shales.—There can be no doubt that this forms an upper division of the preceding, but the fossils are distinct. It consists of black shales and thin slates, similar to the above, and appears to be equivalent to the thin band of Upper Lingula shale, with its fossils, observed in the Malvern district. Mr. Eskrigge, a member of the society, in looking over the speci-

mens, recognised their identity to the Malvern shales, and the following fossils fully bear out this opinion. *Olenus Scarabæoides*, *bisulcatus*, and *humilis*, *Sphærophthalmus pecten* are plentiful.. *Conocoryphe*, *Angelina Sedgwicki*, and unrecognised species of Trilobites, an *Olenus*, with head spines as long as the body. *Agnostus rex*, *A. princeps*, *A. trisectus* are often so thickly spread on the bedding as to give the shale a rough granular character.

The strata overlying are the Tremadoc slates, forming the last of the division of the Lingula beds, or passage beds into the Lower Silurian, these are laid down by the Geological Survey in its Section, No. 37, a little beyond, to the east of the place where the beds of No. 8 were worked, but which, for want of time, were not examined.

In the exploration for the fossils of this collection, many tons of slate, shale, and rocks, have been blasted and broken down, and the specimens subjected to a most searching examination, yet, it is very remarkable, that not even a fragment of the Crustaceans mentioned by the Geological Survey, *Hymenocaris vermicauda*, and *Olenus micrurus* have been detected, for the Olenus we found where *O. micrurus* is marked on the section of the Survey belong to another species, *Olenus cataractes*,—it is singular, too, that although there are many new forms in the collection, the Cruziana and Dictyonema found in Lingula flags elsewhere, have not been found here.

The *Agnosti* are singular in their occurrence, in Nos. 2 and 3 slates, the specimens are fine, large, and pretty plentiful, they are not found in No. 4, the *Paradoxides* slate—small and unfrequent in No. 5—not found in No. 6—only one specimen in No. 7, yet, in No. 8, are found large and abundant, but not more than four species are well defined in all the beds. *Microdiscus* is confined to Nos. 2 and 3 slates, and found at Maes-Clwddyy-ffridd, on the river Cain, and on the Camlan. The specimen of *Sao* is remarkable from its prominence in the Primordial Zone of Bohemia—it has not been found before in

British Lingula beds. The fossils known to have been found previously to this recent exploration were eight, viz.:—*Lingula Davisii*, *Hymenocaris vermicauda*, and *Olenus micrurus* found by the Geological Survey; *Paradoxides Davidis*, 1864, found by Mr. Readwin and Mr. Williamson; *Theca corrugata*, *Olenus* and *Anapolenus*, by Mr. Williamson; and *Conocoryphe* fragments, by Mr. Salter, in October, 1864.

To these have now to be added the following genera and species, about 36 in number.

Crustacea;—*Paradoxides*, two new species; *Microdiscus punctatus*; *Agnostus*, four species or more; *Anopolenus*, several new species; *Conocoryphe*, two or three species; *Sphærophthalmus pecten*; *S. alatus and S. flagellifer*, *Olenus scarabæoides*, *O. humilis*, *O. bisulcatus*, *O. spinulosus*, and about four others: *Angelina*, two species; and *Leperditia*.

Mollusca:—*Obolus*; *Obelella*, *sp.*; *Orthonota Orthis*, *sp.*; *Lingula*, *sp.*

Zoophytes, *&c.*: — *Petraia*, Cord-like fossil; *Bryozoon*; *Fucus*; *Gorgonia*.

These discoveries, valuable as they may be considered to the geologist and palæontologist, are but the commencement of a large catalogue of fossils, with which further explorations will sure to reward any one zealous of carrying on the research; but they indicate also, that the work of the Geological Survey must at some future time be remodelled along the whole line of junction between the Lower and Upper Cambrians in Merionethshire, before a true knowledge of the Primordial Zone or Lingula flags can ever be obtained: meanwhile, there is an opportunity for anyone to spend a week or two in this locality, near Dolgelly, and readily add to the list of fossils already known.

The President said he was sure they must all feel obliged to Mr. Williamson, for doing so much work in so short a time. The good wishes of the society would go with him, and it was to be hoped he would find more gold in Brazil than he had done in Wales, and bring a good deal back with him. He thought they ought to pass a vote of thanks to Mr. Williamson, for the specimens which he had previously forwarded to the society. He believed the first they heard of the occurrence of *Paradoxides* near Dolgelly were some specimens from Mr. Williamson. They would also be glad to have any communications that he might think proper to send to them from Brazil.

Mr. Knowles had great pleasure in proposing that the thanks of the Society be given to Messrs. Plant and Williamson, for their valuable paper and contributions.

Mr. Aitken, in seconding the motion said, the society was greatly indebted to Mr. Williamson, and it would be very remiss, were they not to acknowledge it. They were also greatly indebted to Mr. Plant for the paper to which they had listened.

The resolution was carried by acclamation, and the proceedings terminated.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 15.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, March 27th, 1866.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

The President exhibited to the meeting a nodule of ironstone, found by him in the Wigan Four Feet Coal, containing an immense number of small spores or seeds, about the size of a common pin's head. The outside of the specimen had evident characters of the root of *Sigillaria*, and its inside was full of the spores. These latter were covered by a thick brown cover, one side presenting a rounded appearance, but on the other a triradiate ridge. The inside was composed of beautiful white carbonate of lime. The spores appeared to be more like those of the *Lepidostrobus ornatus*, figured and described by Dr. J. D. Hooker, in plates 5, 6, 8 and 10, in part 2, Vol. II of the Memoirs of the Geological Survey of Great Britain, than of any other with which he was acquainted; but he had not as yet found them in a sporangium. In all cases where he had met with them they were loose and detached. Mr. Carruthers had

described, in the Geological Magazine for last October, a singular cone, found by Mr. James Russell, of Airdrie, which he has termed *Flemingites gracilis*, containing many sporangia similar in form but considerably lesser in size than those found in the Wigan specimen. These sporangia of *Flemingites* are found largely in all the splint coals of Scotland and England, and no doubt have had a great deal to do with their good qualities for iron making and steam raising purposes. In the Fifeshire coals he had found them, in the Eight Feet, Main, Wood and Pirnie Well Seams, at Methill, and in the Barnsley Main, at Handsworth, Woodhouse, east of Sheffield. He believed that Professor John Morris, F.G.S. had also found them in the Better Bed Coal at Low Moor. So far as his (the President's) knowledge extends, all splint coals contained more or less these sporangia. It was only in Mr. Russell's specimens that the sporangia were seen *in situ*, and in all the other cases they were found detached like the spores from Wigan coal-field, now exhibited. It was singular that the sporangium of the *Flemingites* should be so similar in shape and size to the spore of the *Lepidostrobus ornatus*, and so dissimilar to the sporangium of the *Lepidostrobus Brownii* of Carruthers. We required a great deal more evidence of the fructification of coal plants than at present possessed to enable us to thoroughly understand the true nature of the vegetables of the carboniferous epoch. He wished all the members who devoted attention to the collection of coal plants to assist him by all the means in their power in finding cones united to branches, and cones with sporangia and spores *in situ*. These were the most valuable specimens which they could bring before the Society, and it was his opinion that they only required to be diligently searched for in order to be found.

In reply to a question, the President said that the spores in one specimen, which he pointed out, were about the largest he had ever seen: they would split into three sporules. The best samples

of coals containing spores were in the hard coals of Yorkshire and Derbyshire, and the splint coals of Scotland. We had no true splint coals in Lancashire beside the bone coal of Wigan.

Mr. Greenwell said there was a good deal of splint coal in some of the Durham coal seams.

The President remarked that they often used the term splint in Durham to as good cannel as he had ever seen.

Mr. Greenwell said, bearing out what the President had stated about splint and cannel, some years ago on the Tyne, some splint which was obtained was thrown back and wasted, but afterwards its quality was discovered, and its name was changed from splint into cannel coal.

The President said another term for cannel coal was stone coal. There was hardly a coal-field in which the same terms were employed.

Mr. Dickinson enquired if there were not a number of these seeds in the black band ironstone?

The President replied that he had never seen seeds in the black bands, except some found at Airdrie, by Mr. Russell.

Mr. Dickinson believed the Four-feet coal had a roof of black band.

The President—It has.

Mr. Dickinson (in continuation) said they liked these things in the black bands of Scotland.

In reply to a question, what bed was identical in Lancashire with

the Barnsley thick bed, the President said it was pretty clear that the black shale coal about Barnsley was the representative of the Arley coal, but he could not identify the Barnsley thick coal with any Lancashire seam.

Mr. Dickinson said there was a Wigan Nine-feet coal which came somewhere near it, but even that, as seen from Wigan eastward to Manchester, was much changed, both in quality and thickness. Then as you got to Oldham, it was very much more changed. There was great doubt as to the identity; it was supposed to be Black-mine. The ribs were entirely disconnected, and you came into the section afresh, and great changes took place.

Mr. Knowles observed that there were about 40 yards between the hard and soft coal at Staveley.

The President said they had a very good map of the Derbyshire field, by Mr. Gratton, presented to the Society some 30 years ago. He then called attention to some specimens presented by Mr. Thornley of fluate of lime and carbonate of lime, from Castleton.

Mr. Barr moved a vote of thanks to Mr. Thornley for his contribution, which was seconded by Mr. Aitken, and carried.

Mr. Barr then read his Paper on—

A FOSSIL SHELL FROM THE OIL WELLS OF CANADA.

Perhaps the most extraordinary discovery of the present day in natural phenomena has been the oil springs, or the finding by boring of large reservoirs of petroleum oil in certain strata of the earth's surface. Not that these discoveries are entirely new, for isolated cases have been known for centuries, but that never until the present time has the supply been found so abundant and of so

great commercial value. These later discoveries have been confined to the new continent, and first in Pennsylvania, and afterwards in Canada, have yielded to commercial energy and speculative resource a vast field of labour and of wealth.

The origin of these oil wells has caused a great amount of speculation, as well by the scientific man as by others who have not had the knowledge requisite for its demonstration. But, with all this enquiry, I have not been able to find one single paper which from observation has given any idea as to the real origin of this formation of petroleum oil in natural cavities of the earth's surface. Although many have come forward with speculative theories, ascribing the formation to all sorts of chemical action on vegetable or animal substances. Few, as far as I can learn, seem to have taken the trouble to examine the facts for themselves, and none have mentioned the discovery of any of the shells that seem to be found there in abundance, and which are the subject of this Paper. Having been presented by W. L. Eskrigge, Esq., with a few shells which he collected himself from the oil wells of Canada on his late visit to that country, and thinking that they may give us some idea as to the origin of this wonderful deposit, I have presumed to write this short Paper, and bring these fossils before you to-day, not so much to decide the question, as to provoke that healthy discussion which I believe, more than anything else, leads to those true views which should be exercised on all scientific subjects.

The place from which these shells have been brought is the village of Oil Springs, in the township of Enniskillen, in Canada, and they were picked from the stiff blue clay by the above-named gentleman, having been brought up in his presence by the boring tools. Although these four shells are all that he brought over with him, he says that they are in great abundance, as he saw many of them lying about in the clay, and that in a clockmaker's shop in the village he saw a large quantity of them in the window, evidently for sale.

In a Paper on this subject, read before the Canadian Institute by Mr. Sandford Fleming, C.E., the writer gives a little data on which scientific facts may be based. The clay, which seems to be the same out of which our fossils were taken, he says, covers the country to about the depth of 50 feet, and rests upon the rock, of what character he does not mention. He says that after boring through this 50 feet of clay, the wells are sunk from 100 to 230 feet into the solid rock, and sometimes at one depth and sometimes at another, but never as yet below the depth named, is found a good supply of oil, which lasts seemingly in the inverse ratio to its depth, for all the deep wells have failed in a short time, whereas some of the shallowest have had a constant run from the time they were bored, and give no signs of exhaustion at the present day. In most of the wells which have ceased to yield oil, the flow has gone on with the same bore, but the liquid is only salt water.

The whole of the wells of this district, which have been bored and worked with any amount of yield, are within the circumference of one square mile, and even within that district the yield is not uniform. Wells are very often sunk at a short distance from one another, which, from their flow, shew them to be fed from the same reservoir underground; and yet another proprietor having bored in a straight line between them has failed to get one drop of oil. An instance of this is mentioned in the above-named Paper. One proprietor sank a well to a certain depth, and got a good flow of oil; after a short time another person sank, at the distance of about 200 yards, another well, and having tapped the oil, it was found that the two must be in the same reservoir, for when the new well was at work, the old one only yielded half the quantity, and that either of them being stopped, then, and only then, the other had a full flow. These two men decided wisely to join partnership; but what was their astonishment and dismay to find that another proprietor was just boring in a straight line between them. They were just on the point of offering him either a partnership with themselves or some pecuniary compensation for the relinquishment of his

enterprize, when they found that he had bored 50 feet lower than their wells, and had not been rewarded by one drop of oil. From these and other circumstances, I think there is no doubt that the oil, whatever its origin, is deposited in cracks and fissures in the rock into which the boring is made, and that those are the natural ones, which are found in nearly all the older rocks, from the carboniferous downwards, and not formed by or during the deposition of the oil. The age of these underlying rocks is given differently, by different authorities, for as in the case we are speaking of in Canada, they seem to point to a carboniferous limestone; in a description which I see in the *Athenæum* of February 17th, 1866, of a boring at Chicago, they speak of oil being found under that city at 40 feet below the surface, in upper silurian strata, and yet after a further advance of 700 feet through sandstones, limestones, and shales saturated with oil, they find a good stream of water, yielding 500,000 gallons per day, through a 3½ inch bore pipe.

These being the facts, as well as I have been able to collect them, what conclusion can we draw from them? First of all, the fossils themselves, I think, are truly carboniferous, and are the same as our spirifera strata, which is only found in this country in the carboniferous limestone. The oil itself is found in the underlying rock at different depths, but whatsoever character the rock may have, it is certain that this has nothing to do with the origin of the oil it contains, but rather that it has come from some extraneous source, and is only contained in the crevices and cracks with which the rock is permiated. These cracks being better filled, and the yield being more abundant near the surface than deeper, seems to point to the supply coming from above.

Having drawn your attention to these two facts, I would suggest that the origin of the oil is from the now overlying clay, which, from its imbedded remains, must have been a member of the carboniferous series. That it most probably originally was a shale similar in character to our bituminous shales so well known in our coal measures, or a band of bituminous matter as found in the mountain

limestone, but I am more inclined to think that it was originally a shale, from the dark blue clay residue in which these shells are deposited, that by a decomposing process, of which we have no knowledge, the bituminous matter was distilled into an oil, and filled up the cracks of the underlying rocks, forming the reservoirs from which modern energy and skill are now for the first time bringing it to light.

In putting this theory before you, I do it with great diffidence, knowing as I have few facts to dwell upon, I may have formed a wrong judgment, but as I have been unable to find much information on this interesting subject, I trust this short Paper may elicit more information, even if it does so at the expense of my theory.

Mr. Aitken moved a vote of thanks to Mr. Barr for his communication, which was seconded by Mr. Knowles, and carried.

Mr. Aitken then said he should like to ask Mr. Barr whether he considered this bed of clay, which he had described, and which he considered to be deposited shale, and the oil issuing from that bed, whether it was from the organic remains which that shale was supposed to contain? He supposed, as no vegetable matter had been mentioned, he must understand that the oil had been obtained from the animal remains.

Mr. Barr replied that he should think it was from vegetable. He only supposed this clay might have been something like the black shales in our coal measures, which were saturated with the bituminous remains of vegetables.

The President enquired if Mr. Barr had a sample of the clay.

Mr. Barr replied that there was a clay upon these shells when they first came—a hard, stiff, blue clay, from the description. The shells were certainly out of the clay, and not out of the underlying

limestone, otherwise the boring would have split it.

Mr. Plant would not like to venture to give an opinion about the geology of the locality, but the species of shell was undoubtedly not carboniferous; they had a silurian *facies*. It was equivalent, he thought it was identical to the shale which Bigsby called the *spirifa mucronatus* of Canada, and that was found in the middle silurian. Speaking only from what he had read in reference to the oil springs of Canada, he found all the authorities, including Professor Rogers, Hitchcock, Dawson, and Sir William Logan, ascribing the oil source—the petroleum oil—to an even lower position than the middle silurian.

The President said what they wanted to know was how this oil had been formed—how it was now found in certain rocks. They did not see any specimens of these rocks before them, so they could not give much of an opinion upon them. Of course whatever Sir William Logan said carried a great deal of authority with it. As they had no specimen of the rock there, they were groping about in the dark. Some deposits were highly charged with animal as well as vegetable remains, and there was not much difficulty in supposing oil to come from them. Twenty-three years ago he read a Paper before the Society on the natural formation of petroleum, now going on at Downholland by the decomposition of a bed of peat. A most excellent petroleum was obtained there, fully equal to any brought over from the United States or Canada. Unfortunately the quantity was not great, but the quality was undoubted; and there it was formed, and is now being formed, by the decomposition of a bed of peat. The oil extracted was remarkably sweet, and contained paraffine. When you took the peat up you would have thought it contained a great deal of oil, but when it was separated the yield was remarkably small.

Mr. Dickinson referred to the statement of Mr. Barr, that in most of the wells which had ceased to yield oil, the flow had gone

on with the same bore, but the liquid was only salt water. Some years ago an account was given to the Society of the oil found at Astley Pit, Dukinfield. That spring soon ceased to flow as oil, and it passed off into water.

The President remarked that there had been similar springs at Wigan a hundred years ago, and Coalbrookdale had been noted for many years for yielding petroleum. In the pitch coal and flint coal there was also a considerable amount of petroleum, and very good; and he believed it had also been found in North Staffordshire. There was no difficulty in accounting for petroleum in a coal field. By the decomposition of coal at a low temperature you could distil so as to get oil from it. It was generally not so sweet as natural petroleum. All his experience tended to show that our artificial made oils were not so sweet as nature's.

Mr. Barr observed that if the oil was kept for any length of time it was much sweeter.

Mr. Aitken thought the difficulty of obtaining oil much greater when you got down into the silurian, because the vegetation became so scant.

Mr. Dickinson said many of the mountain limestones of this country contained bitumen; there was about three or four per cent. of carbonaceous matter.

The President said that in the limestone of Derbyshire they found not only petroleum but rock leather, which was really solid petroleum.

Mr. Aitken added that a bed of that kind was to be found at Castleton.

Mr. Greenwell inquired if the oil was not sometimes found in faults.

The President, in reply, described a visit which he and Mr.

Young paid some seventeen years ago to Riddings, in Derbyshire. They went down Mr. Oake's pit there, and found oil coming from the roof. It was over the coal—which was a very good gas coal, similar about in position to the Low Moor Better Bed—and it trickled down pretty freely through a little bed of shale from the rock above. It appeared that many of the gaseous matters produced by the low distillation of coal had been given out and condensed in the fissures of the rock, and then fell down on the coal.

Mr. Greenwell inquired if there had been any black shales found among the silurians.

The President—Plenty. All through South Scotland, in Dunfrieshire, they were constantly boring and sinking in these silurian beds to find coal.

Mr. Greenwell—There is no reason physically why the oil should not be in the silurian?

The President—Not the slightest. He thought oil would be found from silurians, perhaps in Cambrian beds; and it might occur in more recent beds, all way up to the peat bogs at the present day. Certainly the oil being met with in peats was as good and sweet as any.

Mr. Aitken thought it undoubted that the petroleum in America was in the fissures of rocks. In addition to what Mr. Barr had stated, in reading, he noticed that where boring had been carried on they generally found, when they came to the oil, that the boring tools suddenly dropped as into a fissure of oil.

The President observed that if a stratum of vegetable matter was subjected to a low temperature it would become decomposed, and yield oil. It was remarkable how some of the American springs, and particularly those in Pennsylvania, held out. Every spring in England had always been soon exhausted. At Rangoon,

on the contrary, 400,000 hogsheads a year were produced from the wells, and this had gone on for centuries.

Mr. Barr thought the great point to decide was whether these fossils were silurian or carboniferous.

The President did not think this point of much importance. He thought they might have springs in silurian or cambrian rocks if they had any animal or vegetable matter in them. The shells exhibited by Mr. Barr were in a very beautiful state of preservation. Shells of this kind often occurred in shale. In Scotland, where the mountain limestone was very thin, good shells were obtained in shale, and they came out very nicely. He should hardly think that the present specimens had come from an oil boring experiment, they were so perfect.

Mr. Barr repeated that Mr. Eskrigge saw them brought out himself. In America they very often dug through fifty feet of clay a well sufficiently wide for a man to work in till they got to the rock.

The President observed that it was very singular the Red Indians knew of these oils when the first European settlers went to America. He referred to a law-suit which he and his partners had to prosecute some years ago, one result of which was to "let the cat out of the bag" as to their first source of obtaining paraffine oil, and which the Yankees speedily followed. Until that time nobody had thought of making any use of the oil in America, excepting to rub their bodies for rheumatism—a plan which was pursued in China and all over the East. He believed also that the Chinese had their oil for burning in lamps for ages.

The meeting terminated with the usual vote of thanks to the President.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 16.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, May 29th, 1866.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

The President announced that the Council had arranged an excursion to Bacup, on the 16th June, for the purpose of examining some of the Geological features of the neighbourhood. He invited those present who wished to join the party to hand in their names to the Secretaries.

The President then read the following letter, addressed to the Secretary:—

CAIRO, (EGYPT), APRIL 9th, 1866.

Dear Sir,

At a meeting of the Manchester Geological Society, reported in the Mining Journal of 23rd Dec., 1865, several mistakes seem to have been made

respecting a specimen of coal, presented by some one of the Visitors or Members. Lest any of these errors should be perpetuated in the Society's published Transactions, I shall feel obliged if you will correct them as follows:

The coal beds referred to at that meeting were explored, and the coal examined, and reported upon for His Highness the Viceroy of Egypt, by Mark Fryar, not (Freer). These deposits are situated N.E. from Olympus (European), near the village of Dranista, and about 20 miles west from the Gulf of Salonica. The coal is of Tertiary age, and is, properly speaking, a lignite, although highly carbonised. It is therefore very different from any coal, which, so far as I am aware, has yet been discovered in Britain.

Having only just returned from a five months rambling in Southern Arabia and Western Africa, accounts for my not having noticed this at an earlier date.

I remain, Dear Sir,
Yours faithfully,
MARK FRYAR, C.E. AND M.E.

P.S.—I ought also to have stated that no operations have yet been commenced with the Dranista coal.

The President exhibited a couple of specimens of reptilian remains, which he thought it worth while to bring before the meeting. One was the jaw of an *Anthracosaurus*, found in the Staffordshire coal-measures; and the other a caudal vertebra of a reptile, about 2½ inches across, taken from the roof of the Dogshaw coal at Captain Fold Colliery, near Heywood. Some years ago it was not fashionable to believe that reptiles existed during the coal period, but latterly they had been met with frequently, and no doubt that, year by year, their number would be increased.

Mr. G. C. Greenwell, F.G.S. produced a fossil which he said might perhaps have some interest, and which had been found in the lower silurian slate near Coniston; and also a piece of greenstone, part of a very large boulder lying near the turnpike in a valley in the vicinity of Langdale, in the same neighbourhood.

The length of this single boulder was 21 feet; it would not be less than 10 feet thick; and it was marked with glacial marks from end to end. The boulder lay in the clay.

Mr. Hull, F.G.S. remarked upon the few boulders found in the clay, they generally being clustered on the surface. He thought he had obtained evidence of glacial action on the millstone grit near a quarry on the top of the ridge, called Burnt Edge, to the north of Horwich Moor, overlooking a deep valley running up from Deane Mill, near Bolton. The turf had just recently been cleared away, and the rock gave every appearance of having been glaciated. It was worn into the usual grooves; the flutings were not very distinct, but the particular form of the surface, smoothed in the same parallel lines, had every appearance of a rock in a glacial district. It was 1150 feet above the level of the sea, and the grooves ran about east to west.

The President inquired if the appearance could be accounted for by pack ice being pushed up, rather than by a glacier coming down.

Mr. Hull said the groovings seemed to run on the top of the ridge. He did not wish to state the opinion that it was produced by a glacier, but by the action of ice, either as floating or pack ice.

The President thought that if rock surfaces were carefully examined as soon as they were bared, more of these marks might be found. It would hardly have been supposed that the soft trias rocks in the neighbourhood of Liverpool should have had ice marks upon them, and yet such was the case as had been shewn by Mr. Morton, F.G.S. About Edinburgh, and in most parts of Scotland, these marks were found upon the hard rocks, but in the soft rocks they did not appear to be seen so well.

The following paper was then read :—

ON THE

HÆMATITE MINES OF THE ULVERSTONE DISTRICT;

By G. C. Greenwell, F.G.S.

The remarkably rich deposit of Hæmatite iron ore in the Ulverstone district of North Lancashire, is now being, and has for the last few years been, largely drawn from; and its products, notwithstanding the cost of carriage, are conveyed very long distances to mix with those ores which, though found in great abundance near the site of the blast furnaces, have not in themselves that quality which, if not improved, would produce iron of first class character. The iron ore of the Ulverstone district has been worked for a great number of years, having been for upwards of 100 years worked at Lindale Moor.

The following abstract from the mineral statistics, by Mr. Hunt, shews the quantity of ore annually produced in this district since the year 1853:—

1854	336,173
1855	336,828
1856	464,853
1857	592,390
1858	438,156
1859	445,046
1860	520,829
1861	519,180
1862	559,391
1863	658,642
1864	691,421

By the above it will be observed that the quantity has more than doubled in the above period. The ore is found to exist in various ways, sometimes it appears to be a regular stratification, with a roof and floor of limestone of the carboniferous period—sometimes it appears to exist in the form of a vein, and sometimes it occurs as filling pockets or sops. These are generally found in the limestone,

but sometimes between the limestone and the clay-slate, the old red sandstone here being wanting, and the clay-slate being a portion of the upper silurian as shewn on the Geological Map published by Professor Ramsay.

The ore rarely if ever crops out to the surface; it, with the accompanying strata, is covered by an alluvial deposit consisting of gravel, clay and sand of variable thickness; in some instances, as at Askam-in-Furness, the thickness of this deposit being 43 yards, the upper portion being clay and the lower four or five yards being sand. Under the sand, immediately above the ore, is a mixture varying in thickness from nil to three feet of dirt, stones, sand and ore, locally known by the name of "pindle." Between the "pindle" and the ore there is no exact parting.

There appear to be several of these strata and veins traversing the Furness districts; one very extensive stratum or bed is extensively worked at Hod-Barrow, and at Askam-in-Furness. The direction of its outcrop into the alluvial deposits is North 45 West by the compass, and both the roof and the floor of the ore, which are limestone, dip at Askam, to the South-west at an angle of about 25°. The length of a drift across the bed, from the top of the limestone underlying, to the bottom of the limestone overlying, the ore is 45 yards, indicating the vertical depth of the bed, if regular, as 22½ yards. The ore *in situ* consists of a hard, compact, agglomerated mass in some places as at Askam, requiring the use of gunpowder in mining it; in other places, however, it is soft and friable. Even where hard, however, exposure at the surface soon disintegrates the mass.

The following analyses of the ore of the Ulverstone district are extracted from the Memoirs of the Geological Survey:—

1. Gilbrow ore, Ulverstone, (A. Dick.)

Description,—Red Hæmatite, unctuous, easily scratched by the file; lustre, sub-metallic; colour, purplish red; streak, bright red; fracture, uneven and minutely crystalline; pieces of carbonate of lime and other minerals occur in it, which getting coloured by the powder, cannot be seen until the specimen is washed.

Peroxide of Iron	86·50
Protoxide of Manganese	0·21
Lime	2·77
Magnesia	1·46
Carbonic Acid	2·96
Phosphoric Acid	Trace
Sulphuric Acid	0·11
Insoluble residue	6·55
	100·56

Insoluble Residue.

Silica	6·18
Alumina, with trace of Iron	0·30
	6·48
Iron, Total Amount	60·55

2. Lindale Moor, near Ulverstone, (J. Spiller.)

The sample was selected from a large quantity of the ore, consisting of fragments of various degrees of hardness, the majority of which were of the hard compact variety, deep grayish purple in colour, and covered with a brownish red unctuous powder; there were also small quantities of fibrous Hæmatite and specular iron, together with quartz and a little earthy matter.

Peroxide of Iron	94·23
Protoxide of Manganese	0·23
Alumina	0·51
Lime	0·05

Magnesia	Trace
Phosphoric Acid	Minute Trace
Sulphuric Acid	0·09
Bisulphide of Iron	0·03
Water, hygroscopic	0·39
Water, combined	0·17
Insoluble residue	5·18
	100·88

INSOLUBLE RESIDUE.

Silica	4·90
Alumina	0·12
Peroxide of Iron	Traces
Lime	Traces
	5·02
Iron, Total Amount	65·98

The mode of mining this ore is as follows :—

Small shafts supported by square timbering are sunk through the alluvium, and usually upon the outcrop under it, of the ore, to a depth of nine or ten feet below the "pindle." Then drifts or levels, are driven about nine feet high and nine or ten feet in width, the superincumbent mass being supported by very strong and closely set timbering, until as much of the ore as is practicable is extracted at that depth, when the timbering gives way and the surface settles down. The shafts are then further sunk, and the ore extracted in the same manner, and the downward process is continued as far as the same is practicable. The result of this mode of working is the formation of immense and very deep settlements of the surface, some of which are upwards of 100 feet in depth. These settlements become receptacles for water, which, during the continuation of the mine in work under them, require to be kept drained by engine power. As some of the mines are not very far distant from the sea, and not more than 50 feet above high

water mark, it may be a question some day as to how far this system of working may be safely practicable.

The exact position and nature of these magnificent deposits is as yet a matter of some doubt. There are in various parts of the country, deposits of Hæmatite iron ore, but I am not aware that there are any others, (excepting those of the Cleator district), which are similar to those of the Ulverstone district.

A comparison of the deposits of Ulverstone with those of the Forest of Dean would be very interesting, both being found in the mountain limestone, and should there be found to be any identity between them, so as to lead to the discovery of their continuity at Ulverstone, as in the Forest of Dean, any doubt as to the exhaustibility of this ore would be finally set at rest. Should this discovery be made Hæmatite iron ore will be found to exist in the entire mantle of limestone surrounding the great lake district, and which, commmencing at Cleator, passes by Ireby, Hesket-Newmarket, near Kirkby-Stephen, Kirkby-Lonsdale, and Cartmel, to the site of the deposit which I have endeavoured to describe.

Mr. Andrew Knowles proposed that the thanks of the Society be given to Mr. Greenwell for his communication, which was unanimously assented to.

Mr. Hull, in the discussion which ensued, inquired if Mr. Greenwell had observed any instances in which the upper surface of the Hæmatite was covered with millstone grit?

Mr. Greenwell replied that he had not.

Mr. Hull, in continuation, said he was informed that it was so in some places. It was so far interesting that the comparison Mr.

Greenwell was attempting, between the Hæmatite in the Ulverstone district and the Forest of Dean, would be borne out in that respect. He thought in the Forest of Dean there were two beds of Hæmatite, one on the top of the limestone and another in the millstone grit. And there they were perfectly continuous, all round the basin, though sometimes only represented by a thread; but the beds corresponded with the dip of the strata, and seemed to be extremely regular. He did not think they were so regular in the Ulverstone district, where, it seemed, there was more than one deposit; in one place it was covered with mountain limestone, as well as resting on mountain limestone; in other places it was covered by millstone grit. It was a question however, which wanted to be worked out in great detail. He was pleased to have heard Mr. Greenwell's paper; any information on the subject was extremely acceptable.

The President remarked that the late Mr. W. Peace, F.G.S. read before the Society a paper on the Iron Ores of Furness, and he, himself, some 25 years ago, wrote a paper on the origin of these iron-stones, and he gave his views upon them then. He went to look at the district, and he found the iron lying in holes in the limestone. In some places, as at Cross Gates, they were about being bared, and he saw them opening the iron ore. It seemed to go right up into the till there. The great deposit of Lindale Moor, which had been worked, he believed, for centuries, was really a valley excavated out of the limestone and then filled with iron ore. As to the age of the ore, his own opinion was that it was since the deposition of the limestone and before the formation of the Permian rocks above it. The holes might have been formed either by swallows, that is, by rock waters charged with carbonic acid, or washed out by the sea. Some years since, Mr. Bolton, a gentleman living near Ulverstone, who had paid considerable attention to this subject, showed him a very remarkable fossil which seemed to mark the age of these beds of Hæmatite iron ore, and which caused him to believe that they were all formed during the deposition of our coal-measures. His reason for dating the age at which these beds occurred, arose

from the fossil which Mr. Bolton shewed him—a good *Sigillaria vascularis*, displaying good internal structure and external characters, all of which had been converted into peroxide of iron. Every portion was preserved in this peroxide of iron. No doubt that plant grew during the carboniferous epoch and was afterwards converted into peroxide of iron. The origin of iron ores was now generally attributed to volcanoes. Some years ago a rich bed of Hæmatite was found in the neighbourhood of Mount Vesuvius. It came out of the volcano as a chloride of iron, and was immediately converted into a peroxide of iron. The general received opinion now was that erosions had been made in the limestone, during the carboniferous epoch, and afterwards filled with iron before the permian sandstone had been deposited over it.

After a few further observations the meeting terminated with a vote of thanks to the President.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 17.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, June 26th, 1866.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

The President said that Mr. John Mackenzie, Mining Engineer, formerly of Wigan, and now of West Maitland, New South Wales, a gentleman well known to many of the members, had sent him some specimens of Cannel Coal (exhibited) from West Hartley, N.S.W., which were stated to be superior to the celebrated Boghead coal. One sample was said to yield 145, and the other 120 gallons of crude oil per ton. In all respects, the samples exhibited so much resembled Boghead coal, both in appearance and streak, as no one could distinguish the one from the other. The New South Wales coal, like the Scotch one, was very variable, soon disappearing and changing into common coal and black stone resembling blackband. As the Scotch deposit would probably soon be exhausted by the great drains made on it for the manufacture of paraffine oil, this discovery was of great importance. The President said that in 1850

he bought Boghead coal at 13s. 6d. per ton, and it was now quoted at 80s. In 1843, when he read his paper before this Society, showing that petroleum could be produced from the decomposition, or rather, distillation of peat at a low temperature, little was known either of the origin or utility of this product. In 1848 he (the President) went to Down Holland and shewed this deposit to Mr. James Young, and explained how the petroleum was formed. This he did before he accompanied that gentleman down Mr. Oakes' coal pit at Riddings, (Easter, 1849,) and examined the circumstances under which the petroleum occurred there. Since that time it is wonderful to what an extent the manufacture of paraffine oil and the supply of petroleum have reached. Probably no articles of commerce ever made greater strides in the same time. If such had been the case in Scotland and America, no doubt great results would ensue from the discovery of Boghead coal in New South Wales.

In the discussion which ensued,—

Mr. Dickinson said he did not think the specimens in any sense distinct from the best Boghead coal. With regard to the last publication of the Society's Transactions, he found some inaccuracies in his reported observations which required correction. He was saying that he had noticed some inferior blackband on the top of the Wigan Four-feet coal, and that he had, in the Scotch black bands, seen some fossils like those spores which were produced at the meeting. By the way in which this had been condensed, he was made to say that the Scotch people "liked" these fossils in the black bands. Another point was, that in speaking of the identity of the rocks on this side of the basin and the Oldham side, the word "rocks" was printed "ribs." He understood that a proof of the report had been sent to him, but he never received it.

The President then referred to the recent successful excursion from Bacup to Todmorden, and which had led to the desire to have another if the necessary arrangements could be made. During the excursion they passed over a bed of rock, which he used to term Gorse Hall rock, above the forty yards coal and just under the flags, containing a calamite. Mr. Aitken was good enough to get a specimen of it and present it to the Society, although Mr. Baldwin first pointed it out. He thought it a very valuable specimen, showing as it did that the calamite was not a distinct plant, but the cast of the pith of a plant, like *Sternbergia* was the pith of *Dadoxylon*.

The following papers were then read—

THE BEST METHODS TO PRODUCE COAL

IN A MARKETABLE CONDITION;

BY

MR. JOHN WARBURTON.

The title given to this paper would suggest the idea that the best methods are here given, but such I do not claim to be the case. It is with a view to a thorough discussion on the subject I chose the above title, and a hope that it may incite us to a searching investigation on this very important topic. True the "exhaustion of the British coal-fields" has been a subject of discussion, and a theme for calculation, at intervals more or less distant, during the last century. Many and various have been the calculations put forth as to the probable duration of our coal-fields, indeed so various that we find them ranging from 100 to 2000 years.

The difference between the extremes certainly is very wide, and to attempt the proof of any of them would result in failure; yet, to

heedlessly disregard one and all of them would be sheer folly, for we are quite certain, even at the present rate of consumption, that some time or other our coal must be exhausted. With this conviction, it behoves the country, but especially the owners of mineral property, to see to the economisation of this portion of our individual and national wealth. This economisation naturally divides itself into two distinct divisions, first, economy in the production, and second, economy in the consumption.

With the second of these I do not propose to deal, as we have so many smoke consuming inventions, patent fire-grates and stoves, with a host of heat economisers, together with other scientific machines for the economisation of fuel. Notwithstanding all these inventions and appliances, the emissions of our tall chimneys, and the clouds overhanging our streets and villages, indicate clearly enough an imperfection on this side of the question; but this I must leave for some one else, and turn to the first or other side of economising our mineral wealth, and with which, we, as its producers, have more especially to do, viz., economisation in the production of coal.

In most things with which we have to do, or require, the stock is kept up, and our wants supplied by a reproduction of those necessaries, as food, raiment, &c. Fortunately or unfortunately, such is not the case with our mineral wealth, for no amount of labour would reproduce a once exhausted seam of coal. This being the case, we are, in duty to future generations, and interest to ourselves and successors, bound to produce all and every part we attempt, in the most cleanly and valuable condition possible. I may be considered bold, when I say that a large portion of our coal is not cleanly worked, nor is that that is worked or got, in a very many instances, produced in the most valuable condition.

The methods of working coal are almost as numerous as the mining districts of the country; it follows then, that either the

requirements of the different districts render it necessary, or that some of our systems are not as good as others, or, that we think the system in which we were initiated the best. This, I think, is the most likely, as no method seems to us so good as the one with which we are most acquainted, and have imbibed in our earliest mining experience, hence we find people from the north coming to Lancashire and Yorkshire, and introducing northern systems; Lancashire and Yorkshire men carrying their systems to North and South Wales; and, as a rule, men leaving the place of their initiation, carry and introduce that they already know, for, as a matter of course, that that they know is right, and the unknown *may* be wrong. From this, I think, arises the diversity of opinion, more than a conviction of the merits of one system over another.

In order to better understand our subject, let us suppose a lease of 300 acres of a seam of coal 5 feet thick, with its downcast and upcast shafts, together with all necessary plant for working it. We calculate the quantity of coal to be about 2,250,000 tons, but in practice we should not venture to say more than 1,800,000 tons, deducting a clear one-fifth for waste and pillars, thus taking from the 300, sixty acres, or 450,000 tons. A still further deduction do some of our leaders give, for in March, 1860, in a communication to the *Times*, we have Professor Ansted (criticising Mr. Vivian's calculations), saying that not only one-third, which Mr. Vivian had deducted, but two-thirds should be taken off. Suppose we proceed with these calculations on the 300 acres; according to the Professor we have 750,000, Mr. Vivian 1,500,000, common practice 1,800,000 tons getable, while in the bed we know there exists 2,250,000 tons.

Whichever of these calculations we accept as the nearest approximation to facts, it must be humiliating, and by no means is it creditable to the mining profession. Whilst in these calculations—let us put them in a more tangible form—we prove the coal to exist as before stated, amounting to 2,250,000 tons, supposing all this could be got in a marketable condition, and on the whole would

clear for interest and redemption 1s. 6d. per ton, it would amount to £168,750; one-third got, £56,250; two-thirds, £112,500; four-fifths, £135,000, making a difference respectively of £112,500, £56,250, and £33,750, the least of which is a formidable item, £33,750 in only 300 acres. This loss, in some cases, as coal is let in Lancashire, Yorkshire, and the Midland Counties, would all be borne by the lessee, in some places as South Wales, &c., the loss would be sustained by the lessee, and an additional loss by the lessor.

These calculations, we admit, may not be carried out to the figure, but I think it is possible to produce the coal so as not more than one-tenth need be lost or destroyed. Thus reducing the loss on 2,250,000 tons to 250,000, or equivalent to £16,875, which, I am sure is enough to incite our utmost attention to find a remedy and thus avoid this destruction of one of the prime elements of our national wealth. We can look upon it in no other light than a waste of nature's stored bounties.

If there is this loss, which is, by common consent, acknowledged by all connected with mining operations, then, what, if any, are its remedies? The most simple answer would be,—work out the coal in its entirety without destroying or depreciating its value; this at present, we are not prepared to do, in the full sense of the term, for we must leave a portion to support the shafts, which has to be cut through in different directions, thus necessarily reducing its value; but I do say, after a sufficient support is left for the shafts, there need be little or no more ungotten coal, and what is gotten ought to be worked in such a manner as to reduce the waste to a minimum.

What we mean by waste generally, is that portion of the coal we *make* unmarketable by cutting it to a powder, and thus render unfit for commercial purposes. Of this, Mr. Basset, of Cardiff, says, there is as much as 35 per cent. Mr. Warrington, of Castleford, says, he has seen a case where 34 per cent. was thus wasted;

if to this waste we add the amount left, by way of pillars, in some mines the per centage of waste becomes something approaching Professor Ansted's calculations.

The coal and other things being equal, the per centage of waste is highest in localities where "Pillar and Stall" or, "Pillar and Benk" forms the system of working. On this system, of necessity a good deal of coal is cut out in "strait" or "narrow" work, which always *does* produce a large proportion of small coal. This is inevitable, for whenever and wherever a miner's pick comes in contact with the coal it is with the object of cutting or dissevering it. (Indeed it strikes me as marvellous that the law of divisibility was not discovered by miners, for in no art is its practice more thoroughly developed.) The more of strait work there is cut out, it must follow as a consequence that more small coal will be made, or, in other words, more of the coal will be made small.*

Take, for instance, a strait place 8 ft. wide, in a 5 ft. seam, let the miner prepare 3 ft. for getting out, and you have $5 \times 8 \times 3 = 120$ cubic feet. Ere the piece is got out, one foot of an average at each side must be cut out, or one side cut out and the other blasted, which, in point of producing small, is equal to both sides being cut. Then the coal must be "holed," or "kirved," or "bared" a foot high of an average. Out of the 120 cubic feet you cut $5 \times 3 + 5 \times 3 + 8 \times 3 = 54$ feet; $120 - 54 = 66$ of solid coal; but this has another operation to undergo, which, under favourable circumstances, will raise the small coal into full 55 per cent. It must be evident then the less of cutting there is the better will it be for the production of marketable coal.

In this cutting of coal there is another very heavy drawback; it is considered *the* most laborious work in a colliery, and the men who do this kind of work are the cream of the miners; hence it comes

* See the amount of strait work in Plan of a Yorkshire Colliery.

under what our economists call *skilled* labour, and as such requires extra pay for its performance. Thus we have it as the phrase is, "cutting both ways:" cutting it into valueless rubbish, and paying extra for it. We may carry it still further, a point very commonly lost sight of. All this small coal has to be handled by the men, that is, it has to pass through all the processes of loading, wagoning, drawing, banking and all the rest of it, as much as good marketable coal. We are aware that in some places small coal is sent up for very little nominally, but the full value of the labour *is*, and must be paid for, directly or indirectly; and if the small is left in the pit, all the labour the collier would have to do if sent out has still to be done, and, as a matter of course, must be paid for. The miner's labour is his capital, and he must be paid for the use of it, whether it is employed in producing valueless or profitable coal. Cutting coal then is an expensive operation without a corresponding increase in its value; contrary to most other operations, its expensiveness depreciates its value. Notwithstanding all this, there are many systems requiring so much cutting, still worked, that it makes one almost decide there must either be a counter advantage, or we are careless to look into the matter, or else our mines are so profitable as not to force our attention to the best means of extracting their contents in the most valuable condition.

Take, for instance, a few plans of the present systems, representing Lancashire, Yorkshire, Derbyshire and South Wales. See how the two former and South Wales are cut in pieces and sections, dreadfully mutilating the coal; yet all this cutting and inter-cutting does not represent the total of the waste on that system, for a great deal of these cuttings, or roads, are in the same direction as the cleavage, that is technically, the face, board, or slines of the coal exposed or parallel with cuttings, consequently we find the least pressure acting upon the sides divides the coal at the line of cleavage, which, in many cases, is so thin as the pieces so divided break and crumble to powder by the mere turning over; and this kind of

cleavage will proceed from the side of a road, sometimes four or six yards into the solid on each side of the road.

Thus, first of all, by an actual expensive operation, diminishing the value, and then a greater diminution as a consequence of the exposure of the line of cleavage, this being the case, which few will dispute, what an amount of waste must thus be made in those districts where this system of opening out is *the* system! And strange to say, this *is* the system in the largest coal districts in England, as Lancashire, the North of England, Yorkshire, North and South Wales. And not only in opening-out is the line of cleavage exposed, but in all the workings, or the faces, or heads, or stalls the coal is wrought with the line of cleavage, unprotected or open, and when the pressure or weight acts on the face, which it constantly does, the coal is crushed to dust.

I am not at all surprised that this should have been the primitive mode of getting coal, nor am I surprised that it is so much clung to by the miners of the present day, because the coal, on this system is dislodged with such comparative ease.

When we look at all these roads with the waste in opening them, then the waste with the pressure on them, and the waste by the constant pressure on the face of the workings, it is no difficult matter to see that full 35 per cent. of the coal so worked is rendered commercially valueless. As a rule commerce rides rampant over old customs and habits, but, in this case, ease and habit take the lead, and consume a large per centage of the real value ere it finds its way into the ledger.

Revert for a moment or two to the roads or openings cut at right angles to the line of cleavage, or those where the end of the coal is exposed, you will find the pressure has not had the same effect, simply because the weight or pressure acts at right angles to the line of cleavage, thus the coal is sufficient to resist the pressure, or,

if not in all cases, there being no natural cleavage, the coal breaks off in good square merchantable blocks. In this case then we take away one of the evils, namely: that of exposing the line of cleavage; but we have committed one, "that of cutting the roads," which, whether cut on end or face, *must* destroy a portion of coal.

If these statements are correct, which my experience and observation convince me is the case, what we have to do then is, to remove as many of these destroying agencies as we practically can, namely, cutting the coal, exposing the line of cleavage, and working with the line of cleavage constantly exposed. To leave out all these as a plan or system of working coal is by no means novel, for, in the Midland Counties, and here and there a place besides, the system of working is such as very nearly avoids all these points we have named, as most destructive of our mineral wealth.

I agree in the fullest extent with Mr. Vivian, M.P., who on this question, in the House of Commons, on the 12th inst., said, "Some systems of working coal were far more economical than others; the 'Pillar' system being, in his opinion, the most wasteful."

I would say then in all seams, the quality of which being suitable for export or domestic trade, do no *cutting*, and work the coal with the end exposed, so that all the weight or pressure will act at right-angles to the natural cleavage. Do not "hole" or "kirve" in the coal, but in some underlying strata, or intervening, or even overlying bed of unsalable material. In some parts of the country a "holing clunch" is looked upon as a necessary accompanyment; hence a miner once said to me, "If coal is of vegetable origin, how is it there is always a 'holing' dirt with every seam?" His idea of it was perhaps the most rational, being, that the coal was put there for our use, and the dirt accompanying it so as to enable us to get the coal.

To work the coal as described would increase the cost of getting it probably some 10 per cent., but as a set off against this you produce the coal in a much more valuable condition, which very likely will be worth 50 per cent. more. There are certain seams of coal I would not incur the extra 10 per cent. in getting; for instance, such as are suitable in quality only for manufacturing purposes, gas coal, or coal, the small of which will make a superior coke, these and inferior coals of course would be best worked to suit their merchantable value; but, with these exceptions, I would work every seam of good coal on the entire "long wall" system, and the working face at right-angles to the line of cleavage, and hole in some accompanying strata. By these means properly carried out, I assert and maintain, the waste, so much complained of, may be reduced from 35 per cent. to 10 per cent.

Having laid these suggestions before you in a practical form, I leave them for your thought, with a hope that a healthful discussion may result in the adoption of some system that will remove from our shoulders the blame justly attributed to us, of wasting our national wealth.

A vote of thanks was passed to Mr. Warburton for his valuable paper.

A long discussion ensued, in the course of which,—

The President remarked, that Mr. Warburton had been a considerable portion of his life a working collier, that he had worked in various parts, and under various systems, and that, therefore, his opinion on the practical points at issue was entitled to great consideration.

Mr. Dickinson said it was evident from the paper that Mr. Warburton knew something of the subject. Many of the points touched upon he had over and over again been preaching throughout that district, but he should be sorry to think that the "Plan of a Lancashire Mine," exhibited by Mr. Warburton, was a fair specimen of what they could do in that county. It was apparently taken from some published report—indeed one of his own contained something very like it, but he did not mention it from the well-doing of that colliery, but to explain how a serious explosion had occurred. The South Wales plan was a very villanous specimen of a coal mine. The stalls were not parallel, and the pillars were all sorts of thicknesses. The coal itself in South Wales, being naturally of a tender kind, got crushed to pieces, and there was under the system shown fully a waste of 35 per cent. The Yorkshire system, as shown in Mr. Warburton's plan, was scarcely a fair specimen of the best mines, where the bank system was generally adopted. No doubt as little "strait" work as possible should be done in a colliery, and that little just when it was wanted. There was no system, in his opinion, equal to the "long wall" as adopted in some of the Midland counties and in Scotland.

Mr. Knowles asked if the "long wall" system was equally applicable to every kind of mine.

Mr. Dickinson replied that a modified system between the "pillar" and "long wall" suited the Lancashire seams better than any other.

Mr. Warburton said there had been cases where the "long wall" system had been introduced in collieries and failed, but when again tried by those who were determined to succeed, the results had been all that could be desired. It was generally agreed that the real difficulty was in getting a fair trial for the "long wall" system, the colliers being much opposed to it as they got the coal more easily in other ways.

Mr. Andrew Knowles said he had been to a number of collieries where they worked on the "long wall" system, and where they appeared to work very well, getting their coal in good condition; but he did not think the system universally applicable. In connection with mines, there were a great many circumstances which regulated the manner of working. In the north of England they had worked on the "pillar and stall" system, and they might have been necessitated to do it, because of the peculiarity that they wanted coal there in very uncertain quantities, sometimes urgently, at others quietly, according to the state of trade, which is almost entirely dependent upon shipping. They had to work on a system which caused the greatest amount of coal to be exposed for the men to work at during the time the coal was most wanted. He thought it very likely that each district was in the same way governed by certain circumstances which determined the precise mode of working. Their own firm had tried every kind of plan, and they now followed what he called a modified "long wall" system, and they did not find that there was a waste of 10 per cent.—he did not think of 5 per cent. They went into these estimates very closely at times, and shewed a fair production of large coal; he thought they obtained as much as possible out of certain mines—at all events, 90 per cent. They only drove a little strait work, and that when it was wanted, but they made a quantity of large coal out of the "strait" work.

The President thought this statement very creditable to them in Lancashire. At the same time he knew of an instance where, out of a 10 feet seam, they were only taking out 4 feet at the top, leaving 6 feet underneath it, and the mining engineer who allowed that waste was a man in high position.

Mr. Dickinson knew of similar instances, but the coal remaining in could be worked hereafter, although it might suffer considerable damage. It was better to leave this 6 feet entire than some 30 or 40 per cent. in pillars.

The President said it was the general impression that, in the case he had mentioned, the coal would never be worked again.

Mr. Knowles remarked that colliery owners could scarcely be blamed for leaving coal in the ground which would cost more to get than it would fetch in the market. If in some districts they only wanted large coal, and the small could not be profitably procured, he thought owners did right to leave it in the ground. In this district there was a market for all kinds of coal, and very little was wasted. He did not see why any of it should be left in here, and so far as he knew, it was all swept clean out.

Mr. Livsey inquired what was to be done when there were several feet of soft strata entirely unfit to wall with. He knew a mine where they had a soft roof and a soft floor.

Mr. Warburton had not met with a case of that kind; but he had seen a roof of very soft non-laminated material, and there the road was made by timber, and it stood very well. He had seen 700 yards of continuous road in timber.

Mr. Dickinson said he had seen many "long wall" mines with bad roofs—so bad that, before the men dare attempt "holing," they had first to work little scud holes into the coal and insert roof timber before they dare go underneath it.

After some further discussion,

Mr. Warburton said there was a case which he thought would be of value to the Society to mention. He found from the books of a certain colliery where they worked the "pillar and stall" or bank system, that they made fully one-third of slack. But when the "long wall" system was introduced, and the face of the workings at right angles to the line of cleavage, they only made 1-18 of slack. The statement in both cases was taken for twelve months, from

the same pit and same seam, the only alteration that of working the coal.

Mr. Dickinson added that some of the collieries in that county had almost doubled their yield of large coal by altering their system.

ON RECENT EVIDENCES OF

ANCIENT HUMAN HABITATION,

IN POOLE'S CAVERN, BUXTON:

BY MR. JOHN PLANT, F.G.S.

Poole's Cavern is a natural excavation in the carboniferous limestone on the northern slope of Grin Edge, lying about half a mile to the south of Buxton. It has been well-known for several hundred years past, having been described by every writer upon the Peak districts of Derbysbire. It extends in a winding direction far into the limestone cliffs, and is a favourite place of resort for the visitors of Buxton.

There exist many records, in the history of the Peak, of bones of extinct elks, deer, and teeth of elephants having been found, partially buried in the stalactites which encrust the rocky floor at various points, and pieces of Roman pottery, Samian-ware, and coins have occasionally been found in the cavern and about its vicinity. The cavern has every appearance of having been originally formed by the passage of a stream of water through a subterranean channel, but this stream of water appears to have diminished greatly and then ceased to flow many years ago, and the channel cannot now be traced either at the entrance or the exit. The entrance to the cavern is contracted, but a little way in it enlarges into a capacious chamber, lined with stalactite, with

large ones depending from the roof; other lateral chambers and irregularly varying passages continue to the extent of 600 yards, to the head of the cavern.

The floor of the cavern is formed upon the limestone, the middle of it is generally bare, and on the sides are banks of uneven materials, varying from one to nine feet in height. These banks have scarcely ever been disturbed from the time of their first deposition.

In the autumn of last year, the proprietor of Poole's Cavern, Mr. F. Redfern, who is an indefatigable collector and preserver of curiosities found in the cavern and its immediate neighbourhood, thought he would make a "trial" digging into the bank at about 10 yards from the entrance, in the first large chamber, where the bank is fully 8 feet above the limestone floor. The first layer is but a thin covering of decomposing lime and loam lying upon a capping of hard stalactitic matter, averaging about three quarters of an inch thick; underneath this, is a bed of brown clay, having a very small per centage of lime, and averaging about twelve inches thick. Below this clay is another layer of stalactite, not more than a quarter of an inch thick, covering a deeper bed of clay and loam, and this last rests upon a bed of sand and small gravel about 4 feet in thickness. This gravel of irregular thickness, is nearly everywhere present, resting upon the limestone; but from the centre pathway in the cavern it is denuded, exposing the uneven surface of the limestone forming the original river bed. In the lowest bed of clay, the excavators exhumed a great number of bones, a few fragments of rude pottery, charcoal, balls of burnt clay, and small stones. The excavation is a limited one, being only 4 feet wide, and yet the quantity of bones found in that small space would indicate the existence of a perfect "*charnel house*" underneath the extensive banks of clay filling both sides of this ancient cave dwelling.

Mr. Redfern has recently been carrying on further excavations, and I have had several opportunities of examining the work and

the bones and articles already taken from the clay. The greater part of these bones have been broken and cut; they belonged to animals of a domestic kind, such as the cow, sheep, goat, and pig; a few belonged to the deer, goat, and wild boar. At present no recognition of bones of carniverous animals or of extinct species has been made, but the exploration in the clay is too limited, and the examination of the bones but imperfectly accomplished, so that it would be unsafe to rest any conclusions upon negative evidence regarding them, until further and more extensive excavations have been made.

The fragments of rude pottery, bear indications as to material, manufacture, and outside markings, which are the recognized characteristics of the pottery of the earliest tribes of people known in Great Britain. The clay, coarse in grain, is moulded by the hand, and is simply ornamented on the outside with crossed lines, scored with a pointed stick;* the clay pot is baked in a charcoal fire, and the fragments show how simple and uniform was the shape of the vessels. A large ribbed bead of earthenware, covered with a green vitreous glaze, was found; it corresponds to the type of beads of early British or Celtic make, but there is an uncertainty about its exact position in the clay. The charcoal is found mixed with the bones, and it is evident these ancient people used the cavern as a dwelling, cooking their food on the bank as the driest part of what must always have been rather a damp habitation, for even now the dripping from the roof and periodical streams from fissures, render it uncomfortable. At present neither weapon nor offensive implements of any kind have been discovered; the stones in the gravel are not large enough for weapons, and would not be of much service, even to surround the charcoal fires as hearth stones. There are no traces of rusted iron in the clay, which might be looked for from the decomposition of weapons made of metal.†

*See Sir J. Lubbock, "Pre-Historic Times," fig. 114.

†A small chipped flint, and part of an iron blade have since been found.—August 1st.

I refrain from expressing any opinion as to the "age of mankind" to which these remains may be referred; the evidences at present are limited enough to judge from, but their direction is consistent and harmonious. The geological aspect is very simple, shewing that the cavern was once a channel for a subterranean river, which left a thick deposit of gravel along its bed; that afterwards the river contracted its volume, but was subject to floods which left the mud and clay on its banks within the cavern, and that during this period the cavern was used by a race of people of primitive and simple habits, but who possessed domesticated animals. That in time the cavern was again vacated, and the dropping from the roof covered the clay with a stalactitic crust. The cavern became again subject to heavy floods of water by which a second bank of clay was deposited and cemented over with stalactites, and from that period no perceptible change has occurred within the cavern.

Mr. Plant illustrated his paper by a section of the deposits at Poole's cavern, and exhibited several of the bones of animals, and fragments of pottery taken from the clay.

ON THE EXISTENCE OF A

SEA-BEACH ON THE LIMESTONE MOORS,

NEAR BUXTON:

By Mr. John Plant, F.G.S.

During the last three years I have directed my attention to account for the singular characters seen on several spaces of the exposed surface of the carboniferous limestone on the high moors lying about three miles south of Buxton.

After repeated and careful examination of all the attendant features, I have arrived at the conclusion that they are fine illustrations of "*An Ancient Sea-Beach*," remaining in an almost unaltered condition, from the "post-glacial" period of the submergence of the greater part of the land now forming the British Isles.

The town of Buxton, and the surrounding moors, attain altitudes varying from 1,000 to nearly 2,000 feet above the sea level, the culminating point being Axe Edge on the south-west. That part of the moors lying west and south-west belong to the Yoredale Shales and Millstone Grit formations, and the moors and high valleys to the east and south belong to the Carboniferous limestone.

About one mile to the south of Buxton rises Grin Edge, a long ridge of limestone running north-west and south-east; it rests in the middle of a broad valley formed by Axe Edge, Burbage Edge, Long Hill, and Black Edge on the west and north, and by lower hills on the east and south, one of which is Harper Hill. The slopes of these hills form the collecting ground for small rivulets, which fall into the river Wye, near Buxton.

The highest point, called "The Tower," on Grin Edge, is 1435 feet above the sea level, and the top of Harper Hill has nearly a similar elevation. The two are separated by a small valley, the distance from the highest points between these two places being a mile and a quarter as the crow flies.

The north-western slope of Grin Edge and Harper Hill have been scarped into great cliffs by the extensive quarrying of the limestone carried on during many years, and the faces of these cliffs present a grand illustration of the enormous depths of these beds of limestone, the dip of the strata, the cracks, fissures and joints, which everywhere prevail, and abundant specimens of encrinites, corals, and shells are to be found in them, although not so

finely preserved as in the lower beds of limestone upon which the town of Buxton stands.

In carrying on the quarrying operations, it is usually the present practice first to remove the green turf and thin layer of loam and clay which cover the higher ground of the limestone hills, partly because this clay is valuable in a country so destitute of drift deposits of sand and clay, and is carefully utilized for plantations and agricultural improvements, and partly to keep the limestone quarried below as free from impurities as possible. It is in the course of this preliminary operation of laying bare the southern slopes not far from the ridge of the hills that the singular character of the limestone sea-beach is exposed, and its extent and rocky "*sea-shore*" features are so finely displayed. The surface of the fixed limestone, that is, not the loose rock and shingle, on the upper slope of the hills, is seen to be worn into rounded, hollowed, and fantastic shapes, tolerably uniform in depth and size, and extending along a regular line upon the slope of these hills. The smoothed hollows between these wave-worn stones are filled with small loose shingle stones, lying as promiscuously strewn about as is the shingle upon any rocky coast of our present shores.

The lowest edge of this shingle and rocky shore generally ends in a line of bold craggy rocks, at the base of which are blocks of rolled stones lying upon a glacis or terrace of limestone, with a surface rough and uneven from deep hollows and wash-holes, such as are always found on rocky shores at a very low tide.

These craggy cliffs and rough rocks on the terrace are repeated at lower levels to the bottom of the valley; *not so the rocky beach and shingle*. The upper edge of this sea-beach has not yet been anywhere exposed by the removal of the turf, but it probably extends nearly to the crown of the hills, and would therefore have an elevation above the valley of about 400 feet, and above the present sea level of 1435 feet. The length of the sea-beach, which can

now be examined, is about half a mile on Grin Edge, and fully that length on Harper Hill, where it is finely exposed. Standing on the sea-beach at the latter place, and looking north-west across the valley towards the long flank of Grin Edge, the levels of the two portions of sea-beach are seen to be identically the same above the bold craggy cliffs, and there can be no hesitation in fairly concluding that the eastern flank of these hills will be found marked by the rocky *beach and shingle* whenever the turf and clay are removed.

The turf, soil, and clay, together rarely exceed twelve inches in thickness, covering the worn rocks and shingle of the sea-beach; and what is perhaps singular, it is a pure yellowish aluminous clay, free from any grit and stone, with scarcely any perceptible amount of lime in it, very similar to a thin layer of yellow tenacious clay which caps the drift in some parts of Manchester. This clay, however, has found its way low down the joints and cracks in the limestone, and is thus found in pockets of considerable extent as may be seen in the face of the quarries, but it yields neither shells nor fossils of any kind, unless the bones of the larger animals recorded as having been found in fissures filled with this clay are to be considered contemporaneous with its deposition. In the valley the loamy soil and peaty deposits are thicker, and rest upon this yellowish clay.

It is remarkable that there are not to be found any evidences of decomposition from the action of weather and time upon this rocky and shingly beach, the shingle and stones are encased in the clay alone, and scarcely a film of deposit arising from the decomposition of the limestone, if any, has taken place since the sea left the high moors of Derbyshire, can be found. The rocks and stones are smoothed and bleached, the fossil shells and encrinites in them are to be seen and felt as a loose gritty covering, but nowhere are those

signs of calcareous or marly deposits to be found on this ancient "sea-beach."

The paper was illustrated by a map of the hills south of Buxton, shewing the direction and situation of the "sea-beach," a view and section of the beach on Harper Hill; and Mr. Plant exhibited specimens of the clay and shingle stones taken from both Grin Edge and Harper Hill.

A vote of thanks to Mr. Plant for his interesting papers was agreed to.

In reply to a question from the President,

Mr. Plant stated that the clay found on the sea-beach was a pure aluminous clay, and not at all like the loamy clay found in the cavern. He thought the parting occurred in this valley between the carboniferous limestone of Grin Edge, and the millstone grit of Axe Edge.

The President remarked on the frequency of these sea-beaches in North Lancashire and Westmoreland, and the agencies which had formed them. He thought the action of the sea, the atmosphere, and chemical causes should all be taken into the account. He thought an excursion in that neighbourhood would prove interesting. He mentioned the discovery, by Mr. Prestwich, of sea-beach shells between Macclesfield and Axe Edge,—of *Turritella* and *Purpura*,—and these were found in a bank of sand and clay, 1150 feet above the sea level, and had been undoubtedly deposited when the sea was there.

Mr. Dickinson said that in the chalk beds there were quantities of similar matter to that deposited in crevices, extending to a considerable depth; and he also looked upon that as being a simultaneous formation with the chalk; that when the segregation of the particles took place, the chalk went to itself, and these clayey matters went into crevices by themselves, by a process of crystallisation, or whatever else it might be called.

Mr. Dickinson said this being the last meeting of the Society, he begged leave to move a vote of thanks to the President, not only for his services on that day, but throughout the session.

The resolution was unanimously adopted.

The President in returning thanks, said he was much obliged for the vote, and any further service he could render to the Society would be cheerfully given. He had now been a member nearly thirty years, and he hoped for almost the remainder of his life to take an interest in the proceedings of the Society.

The meeting then terminated.

ERRATA.

At page 241

In the fourth line, instead of "*they had*" read "*it had*"

" fifth " " "*shale*" read "*shell*"

" sixth " " "*spirifa*" read "*spirifer*"

and instead of "*Middle Silurian*" read "*Devonian*"

Stanford University Libraries
3 6105 008 195 369

LOCKED STACKS

212956